LMG 1401

LTER

Cruise Data Report

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31 Dec, 2013 – 09 Feb, 2014

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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 with Joliet extensions. This data format has somewhat 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All of the data has been archived with the Unix "tar" command and/or compressed using Unix "gzip" compression.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
```

DVD Directory Structure

Disc 1:	Disc 1 (continued):	
ADCP: ADCP.tar Cal: ctd/ mocness/ uw/ Imagery: Imag.tar Logsheet: AIR.pdf Drifter_44162.pdf Drifter_123272.pdf Maps: LMG1401.jpg Mocness: (mocness data) Ocean: ctd.tar process: JGOF.tar PCO2.tar PROC.tar QC.tar Report: REPORT.docx REPORT.pdf rvdas: nav/ uw/ Utility: Acrobat/ Winzip/ Waypoint: waypoint.txt	Science: AC-9_Repair/ B-019/ B-020/ B-045/ Bottle Data/ eLog/ KohutMooring/ MartinsonMoorings/ Proposal/ PRR_Data/ SedTraps/ StarOddi_ForAC9/ USF_Drifter/ Weekly Reports SITREPS/	

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 .

Calibration

/Cal/

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.

Imagery

/Imagery/

This directory contains things such as ice imagery, isobar charts, sat imagery, wave and wind images, and weather reports.

Logsheets

/logsheet/

This directory contains scanned paper log sheets in PDF format for various science of opportunity or projects or cruise related science, including such things as XBT's, XCTD's, air sample log sheets, oxygen system maintenance logs, etc.

Maps

/Maps/

This directory maps and mapping data generated by the ship's MCIS and automated scripts, usually in JPEG or PostScript format, plus any maps provided for this purpose by the on-board science party.

MOCNESS

1-meter and 10-meter

Mocness/

The MOCNESS data resides in the MOC1.gz and MOC10.gz archive for the 1-meter and 10-meter respectively. The data set from each cast is made up of three files. The filenames consist of the station number and an extension: .pro .raw or .tab. The type of data in each file is listed below.

.pro	processed data in space delimited tabular format
.raw	raw cast data in ASCII text format
.tab	statistical summary in space-delimited tabular format

Processed filename *.pro

This file contains the processed data for each tow, written in ASCII to disk in a simple configuration, which consists of:

Rows 1-5	header information about sensors and the tow
Row 6	the column headings (discussed below): time pres echo temp theta sal sigma angle flow hzvel vtvel vol net fluor ptran oxycurrent oxytemp oxygen lat lon
Succeeding rows	data for each column heading with each value separated by 2 spaces.

time	Julian day, hours and minutes expressed as decimal
pres	depth (m)
temp	temperature degrees C
theta	potential temperature, formulae from Fofonoff and Millard 1983
sal	salinity ppt
sigma	potential density, formulae from Fofonoff and Millard 1983
angle	angle 0-90
flow	flow counts 0000-9999
hzvel	horizontal velocity (knots)
vtvel	vertical velocity (m/min)
vol	seawater volume filtered (m3)
net	net number
fluor	fluorescence (0-5 volts)
ptran	extinction coefficient (0-5 volts)
oxycurrent	0-5 volts
oxytemp	0-5 volts internal to the probe
oxygen	dissolved oxygen (ml/l)
lat	latitude decimal degrees
lon	longitude decimal degrees

Raw filename *.raw

This file contains the raw data from the underwater unit. These “*.raw” files can be used in the playback mode to re-process the data (see page 33 MOCNESS instructions), and also serve as the backup in case there are problems with the processed data file.

For each tow, data is written (as it appears in the acquisition window) in ASCII to disk in a simple configuration, which consists of:

Rows 1-5	header information about sensors and the tow
Succeeding rows	raw data string formatted thusly: #MN- N1 N2 AA FFFF PPPPP PTPT TTTTTT CCCCCC BBB $GPGLL

The fields are as follows and are discussed individually below.

N1	net count, counts of left response switch, 00-99
N2	net count, counts of right response switch, 00-99
AA	net angle in degrees, 00-99
FFFF	flow counts, 0000-9999. Reset to 0000 with every net response or increment net # button command
PPPPP	pressure value, converted to decibars by the deck computer
PTPT	a decimal number derived from the temperature sensor in the pressure sensor which is used to improve the pressure calibration
TTTTTT	averaged SeaBird temperature period. The frequency from the SeaBird temperature sensor is measured and processed in the NCU to generate the value TTTTTT, a 6-digit decimal number. This number is scaled as follows: (frequency of the temp. sensor)=K/(TTTTTT) where K=1,258,291,200. Software in the deck computer uses this frequency value along with the individual sensor's calibration file to calculate temperature.
CCCCCC	averaged SeaBird conductivity period, handled exactly like the temperature frequency and the same scaling factor should be used
BBB	battery voltage (divide value by 10)
$GPGLL	latitude and longitude in decimal degrees

Tab filename *.tab

The statistical summary for a given *.pro file. For each net, the following parameters are included:

pmin,pmax,pavg	minimum, maximum and average depth of net
tmin,tmax,tavg	minimum, maximum and average temperature of net
smin,smax,savg	minimum, maximum and average salinity of net
amin,amax,aavg	minimum, maximum and average angle of net
spmin,spmax,spavg	minimum, maximum and average horizontal velocity (kt) of net
armin,armax,aravg	minimum, maximum and average vertical velocity (m/sec) of net
#obs	total number of observations while net was open
vol	total seawater volume filtered for net

Captured screens, filenames *.bmp

This file is bitmap image of the acquisition software captured at any point during a MOCNESS "flight". The files on this CD reflect the acquisition window at the end of each "flight", immediately prior to ending acquisition.

Ocean (CTD, XBT and XCTD)

/Ocean/CTD

The ctd data was collected and processed on a computer running Windows XP, using Seasave Win32 – Version 7.20 and SBE Data Processing – Version 7.21

For more information and software visit the web site at www.seabird.com.

/Ocean/CTD/Configs/

This directory contains the Seabird .xmlcon config file. This file contains information of which sensors where used and what freq or volt the where connected to.

/Ocean/CTD/Scripts/

This directory contains the batch file and psa files that we used for post processing the data. The data was processed with the standard seabird processing method. This is just a preliminary processing which was done to verify that the sensors were functioning properly during the cruise. The raw data should be re-processed using the pre and post cruise sensor calibrations.

/Ocean/CTD/Raw

This directory contains the raw file collected at each CTD cast, which is represented by a set of four files containing a bottle-firing file (.bl), a configuration file (.xmlcon), a data file (.hex) and a header file (.hdr). Casts are named with the following g501CCC.ext, where g is for the LMG, 501 is the cruise 05-01, CCC is the cast number. For example; the raw files associated with the Cast 1are: g501001.bl, g501001.con, g501001.dat, g501001.hdr. The raw data files(*.hex) are binary files.

/Ocean/CTD/Graphs

This directory contains graphical plots of each CTD cast.

/Ocean/CTD/Process

This directory contains the processed data files for each CTD cast, the processing method used is briefly described in the above section *CTD/Scripts/.* Also see the above section *CTD/Data/raw* for a description of the file naming convention used. Each processed cast is represented here by a set of ten files:

GXXXCCC.xmlcon	A copy of the configuration file for the cast.
GXXXCCC.cnv	The converted file for the whole cast.
GXXXCCC.ros	The rosette file that contains the scan lines for each bottle trip.
GXXXCCC.btl	The bottle file that contains the avg, standard deviation, min, and max for a select set of variables for each bottled fired during the upcast.
dGXXXCCC.cnv	The converted file for the down cast.
dGXXXCCC.asc	An ASCII formatted file for the down cast without a header.
dGXXXCCC.hdr	The header for the down cast.
uGXXXCCC.cnv	The converted file for the up cast.
uGXXXCCC.asc	An ASCII formatted file for the up cast without a header.
uGXXXCCC.hdr	The header for the up cast.

/Ocean/XBT

Contains a zip archive of XBT data generated for the Drake Transect by NOAA standard “AMVERSEAS” software. Non-Drake transect data may also be included, which will a combination of binary and ascii files generated by standard Sippican MK-21 software. 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.

/Ocean/XCTD

Expendable Conductivity, Temperature, and Depth (XCTD) digital probes were used to obtain water column temperature and Salinity profiles. The two files were created for each drop .RDF files contain the raw data, and the .EDF contain the exported ascii data.

Data and Science Report

/Report/

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

Science

/Science/

This directory, if populated, contains data specified by the on-board science party.

WAYPOINTS

/waypoint/

Contains the waypoint file used for the cruise; this is read by the DAS system and the selected waypoint is displayed on the CCTV system.

QC Plots

/process/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

/Process/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	Not used	-
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	Volts (0-5)
21	PSP	W/m^2
22	PIR	W/m^2

pCO2-merged Data Set

/Process/PCO2/

```
00+346:23:58:20.672 2000346.9991 2398.4 1008.4 0.01 45.4 350.3 342.6 15.77 Equil -43.6826
173.1997 15.51 33.90 0.33 5.28 9.05 1007.57 40.0 14.87 182.44 -1
```

Field	Data	Units
1	RVDAS time tag	
2	pCO_2 time tag (decimal is fractional time of day)	yyyyddd.ttt
3	Raw voltage (IR)	mV
4	Cell temperature	°C
5	Barometer	MBar
6	Flow rate	ml / min
7	Concentration	ppm
8	pCO_2 pressure	microAtm
9	Equilibrated temperature	°C
10	Sea Water Temp	1 or 2 digits
11	Valve position	°C
12	Flow source (Equil = pCO_2 measurement)	text
13	RVDAS latitude	degrees
14	RVDAS longitude	degrees
15	TSG external temperature	°C
16	TSG 1 salinity	PSU
17	Fluorometer	V
18	RVDAS true wind speed	m/s
19	RVDAS true wind direction	degrees
20	Barometric Pressure	mBars
21	Uncontaminated seawater pump flow rate	l/min
22	Speed over ground	knots
23	Course made good	degrees
24	Oxygen	µM
25	TSG 2 internal temperature	°C
26	TSG 2 salinity	PSU
27	TSG 1 internal temperature	°C
28	H2O Input Source	-1 stern thrustor 0 moonpool

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	Gill Ultrasonic
PAR, (Photosynthetically-Available Radiation)	lmwx	continuous	1 sec	BSI QSR-240
Barometer	lmwx	continuous	1 sec	R. M. young 61201
GUV	lguv	continuous	1 sec	GUV2511
Port Ultrasonic Wind Speed/Direction	lmwx	continuous	1 sec	Gill Wind Observer II
PIR (LW radiation)	lmwx	continuous	1 sec	Eppley PIR
PSP (SW radiation)	lmwx	continuous	1 sec	Eppley PSP
Oxygen	lgo2	continuous	1 min	UCAR Oxygen system

Navigational Data

Measurement	File ID	Collect. Status	Rate	Instrument
Trimble GPS	tgps	civilian mode	1 sec	Trimble 20636-00SM
Gyro	lgyr	continuous	0.2 sec	Meridian Bridgemate Gyro
Garmin GPS	lgar	continuous	1 sec	Garmin 17
Seapath GPS	Lsep	Continuous	1 sec	Seapath 330

Geophysical Data

Measurement	File ID	Collect. Status	Rate	Instrument
Bathymetry	lknu	variable	Varies	Knudsen Chirp 3260
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)	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 – 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
Garmin 17 GPS	lgar
Seapath 330 GPS	lsep

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

lknu – Knudsen Chirp 3260 Sonar

```
14+002:19:07:04.648 3.5kHz,4000.92,1,12.0kHz,4001.12,1,1500,-57.343073,-63.750720
```

Field	**Data**	**Units**
1	RVDAS Time Tag	
2	3.5kHz – low frequency header	
3	LF - depth to surface	meters
4	LF – Depth Valid Flag	
5	12.0kHz – high frequency header	
6	HF - depth to surface	meters
7	HF – Depth Valid Flag	
8	Sound speed velocity	m/s
9	Latitude	Dec degrees
10	Longitude	Dec degrees

lnds – 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

lwn1 - 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	

lmwx - Campbell Meteorological DAS

```
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 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 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+034:13:52:14.454 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

Lsea – wet wall flows, transmissometer

```
12+004:12:01:04.438 WetLab_1,14.1,XMISS,3.098,V,0.000,0.000,0.000,-928.535,-
220.566,0.000,0.000,T,NAN,NAN,NAN,NAN,P,0,0,F,47.91811,0,6.815308,0,0,0,0,0,I,1,1,1,1
```

Field	Data	Units
01	RVDAS Time Tag	
02	WetLab_1	Text
03	Internal Temperature	°C
04	XMISS	Text
05	Transmissometer	V
06	V	Text
07	Double Ended Voltage 1	V
08	Double Ended Voltage 2	V
09	Double Ended Voltage 3	V
10	Voltage 1	V
11	Voltage 2	V
12	Voltage 3	V
13	Voltage 4	V
14	T	Text
15	Temperature 1	°C
16	Temperature 2	°C
17	Temperature 3	°C
18	Temperature 4	°C
19	P	Text
20	Pulse Counter 1	Number
21	Pulse Counter 2	Number
22	F	Text
23	Flow Counter 1	Number
24	Flow Counter 2	Number
25	Flow Counter 3	Number
26	Flow Counter 4	Number
27	Flow Counter 5	Number
28	Flow Counter 6	Number
29	Flow Counter 7	Number
30	Flow Counter 8	Number
31	I	Text
32	Digital Input 1	Number
33	Digital Input 2	Number
34	Digital Input 3	Number

Field	Data	Units
35	Digital Input 4	Number

utsg – microTSG, Thermosalinograph

For further information on this data, check www.seabird.com for 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

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	

lgo2 – Oxygen System

For further information on this data, please contact Britt Stephens at stephens@ucar.edu

```
12+301:22:35:30.558 81300.8 16.0 32.0 000.0 005.0 1.2589631 1.2379622 744.549 111.853 131.642 -
2.089 -2.448 723.594 002.50 086.43 099.74 002.77 000.97 050.65 0.000 001.19 065.59 039.48
1966.097 01.345 37.0171 37.8433 000.0 000.0 20.66 20.41 -92.0 28.66 37.44 42.33 37.80 47.95 0.0
01.88 0.0001711 0.0001712 0.0000747 0.0000725 02.657 02.678 -1 0.0000895 -043.94
```

Field	Data	Units
1	RVDAS Time Tag	
2	jsecoday - Seconds since midnight	
3	jselflag - 8 bit decimal value indicated selected gases	
4	jprgflag - 8 bit decimal value indicated purged gases	
5	jmfcflag - 8 bit decimal value indicated mass-flow controller states	
6	jgenflag - 8 bit decimal value indicated other parameters	
7	jfcv1 - voltage on Fuel Cell #1	
8	jfcv2 - voltage on Fuel Cell #2	
9	jpfcell - pressure in torr at fuel cells	

10	jlico2a - CO2 in ppm in Li7000 Cell A	
11	jlico2b - CO2 in ppm in Li7000 Cell B [CO2 MEASUREMENT]	
12	jlih2oa - H2O in ppt in Li7000 Cell A	
13	jlih2ob - H2O in ppt in Li7000 Cell B	
14	jlipb - pressure in torr at Li7000 Cell B	
15	flmfcset - mass-flow controller set voltage	
16	jfll1 - flow in sccm on Inlet Line #1	
17	jfll2 - flow in sccm on Inlet Line #2	
18	jfllt - flow in sccm on Long-Term reference cylinder	
19	jflcal - flow in sccm on selected Calibration cylinder	
20	jflwta - flow in sccm on selected Working Tank Cylinder	
21	jvsoset - purge line voltage-sensitive orifice set voltage	
22	jflpurge - flow in sccm on purge line	
23	jflwtb - flow in sccm on Working Tank line through sensors	
24	jflsp - flow in sccm on Span line through sensors	
25	jpfridge - pressure in torr inside fridge trap	
26	jtfridge - temperature in C inside fridge trap	
27	jtmpt - fuel-cell control temperature (thermistor) in C for MPT10000	
28	jtfcell - fuel-cell thermistor temperature in C	
29	jtach1 - rmp of fan inside Line #1 Inlet	
30	jtach2 - rmp of fan inside Line #2 Inlet	
31	jtcyl1 - temperature in C from cylinder box RTD #1	
32	jtcyl2 - temperature in C from cylinder box RTD #2	
33	jtchill - temperature in C from chiller RTD	
34	jtamb - temperature in C RTD near Analyzer Box electronics	
35	jtomega - Analyzer Box control temperature (RTD) for Omega CNi2332	
36	jtu4ch - temperature in C inside USB4CH 24-bit A/D box	
37	jtfcrtd - fuel-cell RTD temperature in C	
38	jtirga - temperature in C inside Li7000	
39	jliflags - Li7000 status flag	
40	jlirhsrc - Li7000 source/detector relative humidity	
41	jsdfcv1 - standard deviation of 1-Hz Fuel Cell #1 voltage	
42	jsdfcv2 - standard deviation of 1-Hz Fuel Cell #2 voltage	
43	jslfcv1 - slope of 1-Hz Fuel Cell #1 voltage	
44	jslfcv2 - slope of 1-Hz Fuel Cell #2 voltage	
45	jsdco2a - standard deviation of 1-Hz Li7000 Cell A CO2 in ppm	
46	jsdco2b - standard deviation of 1-Hz Li7000 Cell B CO2 in ppm	
47	posneg - flag indicating position of fuel-cell changeover valve	
48	jogdeltadiff - amplitude of 3-jog O2 difference-signal [O2 MEASUREMENT]	

loxy – Oxygen (Part of PCO2 system, separate from Oxygen System)

For further information on this data, contact Tim Newberger at ***tim.newberger@noaa.gov***

```
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 ***tim.newberger@noaa.gov***

```
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	Gas flow	mL/min
7	VCO2 dry value	PPM
8	PCO2 wet/Delta value	PPM
9	Equilibrator Temperature from RTD	°C
10	Equilibrator Temperature from SBE-38	°C
11	Solenoid 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

NOTE: This value does not represent or reflect the sound speed in the ocean, and is for internal use by the ADCP.

```
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 typically 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).

lgyr - Gyro

```
02+315:23:59:58.616 $HEHDT,287.7,T*25
```

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	

lsep – Seapath 330 GPS

INZDA: Time and Date Data

10+351:23:59:58.142 $INZDA,235958.08,17,12,2010,,*78

Field	Data	Units
1	RVDAS Time Tag	
2	$INZDA Tag	
3	time	hhmmss.ss
3	day	dd
4	month	mm
5	year	yyyy
6	(blank)	
7	Check sum	hexadecimal

INGGA: Global Positioning Fix Data

10+351:23:59:58.142 $INGGA,235958.07,6118.168460,S,06008.089527,W,1,12,0.7,22.57,M,17.79,M,,*46

Field	Data	Units
1	RVDAS Time Tag	
2	$INGGA Tag	
3	Time (UTC)	hhmmss.ss
3	Latitude in degrees with decimal minutes	ddmm.mmm
4	{N|S} (latitude is north or south)	
5	Longitude in degrees with decimal minutes	ddmm.mmm
6	{E|W} (longitude is east of west)	
7	GPS quality indicator: 0 = invalid position, 1 = GPS SPS used, 2 = DGPS used, 3 = GPS PPS used, 4 = GPS RTK used, 5 = GPS float RTK used, 6 = dead reckoning	
8	Number of Satellites in use (00-99)	
9	HDOP	
10	Height above ellipsoid in meters	m.mm
11	M	
12	Age of DGPS corrections in seconds	ss.ss
13	M	
14	(blank)	
15	*Check sum	hexadecimal

INRMC: Recommended Minimum Specific GNSS Data

10+351:23:59:58.200 $INRMC,235958.07,A,6118.168460,S,06008.089527,W,12.8,331.22,171210,11.3,E,A*1C

Field	Data	Units
1	RVDAS Time Tag	
2	$INRMC 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	
14	*Check sum	

INVTG: Speed Over Ground, Course Over Ground

14+025:23:59:59.100 $INVTG,32.69,T,,M,10.6,N,19.6,K,A*1A

Field	Data	Units
1	RVDAS Time Tag	
2	$INVTG Tag	
3	Course over ground, degrees true	d.dd
4	T	
5	,	
6	M	
7	Speed over ground in Knots	k.k
8	N	
9	,	
10	K	
11	Mode	

Field	Data	Units
12	Checksum	

PSXN,20: Data Quality

10+351:23:59:58.200 $PSXN,20,1,2,0,0*38

Field	Data	Units
1	RVDAS Time Tag	
2	$PSXN Tag	
3	20 (PSXN identifier)	
3	Horizontal position and velocity quality: 0 = normal, 1 = reduced performance, 2 = invalid data	
4	Height and vertical velocity quality: 0 = normal, 1 = reduced performance, 2 = invalid data	
5	Heading quality: 0 = normal, 1 = reduced performance, 2 = invalid data	
6	Roll and pitch quality: 0 = normal, 1 = reduced performance, 2 = invalid data	
7	*Check sum	hexadecimal

PSXN,23: Roll, Pitch, Heading and Heave

10+351:23:59:58.213 $PSXN,23,0.02,-0.76,330.56,*0B

Field	Data	Units
1	RVDAS Time Tag	
2	$PSXN Tag	
3	23 (PSXN identifier)	
3	Roll in degrees. Positive with port side up.	d.dd
4	Pitch in degrees. Positive with bow up.	d.dd
5	Heading in degrees true	d.dd
6	Heave in meters. Positive is down	m.mm
7	*Check sum	hexadecimal

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)	
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 – Latitude/Longitude

```
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	Longitude	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	

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
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 – Latitude/Longitude

```
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	Longitude	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	1246001-WC45	N/A	Collected
Starboard Anemometer	Gill Ultrasonic Wind Observer II	1246002-WC45	N/A	Collected
Barometer	R.M. Young 61201	BP00873	24-Oct-2012	Collected
Humidity/Wet Temp	RM Young 41372LC	06133	07-Dec-2012	Collected
PAR for Mast	Biosph. Inst. QSR-240P	6393	1-Oct-2012	Collected
PIR	Eppley PIR	28903F3	14-Dec-2012	Collected
PSP	Eppley PSP	28933F3	20-Dec-2012	Collected
GUV (Mast)	Biosph. Inst. GUV-2511	5126	28-Jan-2013	Collected
Transmissometer	WET Labs C-Star 25 cm deep	CST-553DR	01-Oct-2012	Collected
MicroTSG (Primary)	Sea-Bird 45	243	05-Jan-2013	Collected
MicroTSG (Secondary)	Sea-Bird 45	390	09-Apr-2013	Collected
Digital Remote Temp	Sea-Bird 38	390	15-Nov-2012	Collected
Fluorometer	WET Labs ECO-FL	FLRTD-380	23-Aug-12	Collected

CTD Sensors

Sensor	Description	Serial #	Cal. Date	Status
CTD Fish	Seabird SBE9Plus	0377	19-Apr-2013	Collected
Primary Temperature	Seabird SBE3	5034	07-Nov-2012	Collected
Secondary Temperature	Seabird SBE3	2658	07-Nov-2012	Collected
Primary Conductivity	Seabird SBE4	2247	07-Nov-2012	Collected
Secondary Conductivity	Seabird SBE4	2293	07-May-2013	Collected
Primary Dissolved Oxygen	Seabird SBE43	200	07-Nov-2012	Collected
Secondary Dissolved Oxygen	Seabird SBE43	196	07-Nov-2012	Collected
Fluorometer	Wet Labs ECO	FLRTD-8399	21-Mar-2013	Collected
PAR	Biosph. Inst. QSP-2300	4561	23-Jan-2013	Collected
Transmissometer	Wet Labs C-Star	CST-248DR	12-Sep-2012	Collected

Mocness Sensors

Sensor	Description	Serial #	Cal. Date	Status
Temperature	Seabird SBE3	31619	21-Feb-2012	Collected
Conductivity	Seabird SBE4	2048	31-Jan-2012	Collected

Fluorometer Calibration Changes

Customer Alert: July, 2011

CHLa Scale Factors Shift

WET Labs calibration testing has revealed that our CHLa solid proxy used to calibrate our ECO and Wetstar fluorometers allows a large amount of instrument to instrument variability. Also, we have differences in scaling between Wetstar CHLa fluorometers and ECO CHLa Fluorometers because of differences in the solid proxy used to characterize these instruments. A new methodology using a liquid proxy has been implemented to assure stable calibrations between instruments and to match up the ECO FL and Wetstar FL corrected data outputs.

Instruments affected:

All CHLa ECO fluorometers built or calibrated before January 2011.

All CHLa Wetstar fluorometers built or calibrated before July 2011.

WET Labs' Actions:

New Instruments:

WET Labs has instituted a new calibration standard solution preparation methodology. All new ECO/Wetstar CHLa fluorometers delivered from this date forward will have range characteristics as per current specifications and scale factors.

Instruments returned for service and calibration:

Instruments returned for service and calibration will be calibrated using the new methodology. We are tuning all service instruments to this new liquid proxy to decrease instrument to instrument variability.

In some cases, we will not be able to achieve the previously stated range of an instrument. In these cases, we will strive for the highest resolution with the highest signal to noise ratio possible.

WET Labs service technicians will incorporate these improvements during service when practical. WET Labs' term for this service is 'retuning.' Accordingly, a serviced instrument may well have a better performance after retuning than when it was first built.

For instruments that are retuned, benefiting in either resolution or signal to noise ratio, WETLabs can provide pre calibration data to allow you to link your data sets prior to service with your data sets after the instrument is returned to you.

Recommended Customer Actions:

If you calibrate your instruments then you do not need to take any action. Continue to use your calibration.

If you report scaled or raw data, you should adjust your reported values.

For instruments returned for service, you will use the ratio between the previous scale factor and pre-service scale factor. This ratio will cover both the change in the methodology and any change in your instrument between the previous calibration and this servicing.

Use the post-service scale factor going forward.

Underway Calibration Sheets

Note: Embedded pdf files can be opened by double-clicking.

Thermosalinograph (temp) – Primary

Sea-Bird Electronics, Inc.
13431 NE 20th Street, Bellevue, WA 98005-2010 USA
Phone: (+1) 425-643-9866 Fax (+1) 425-643-9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 0243
CALIBRATION DATE: 05-Jan-13

SBE 45 TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

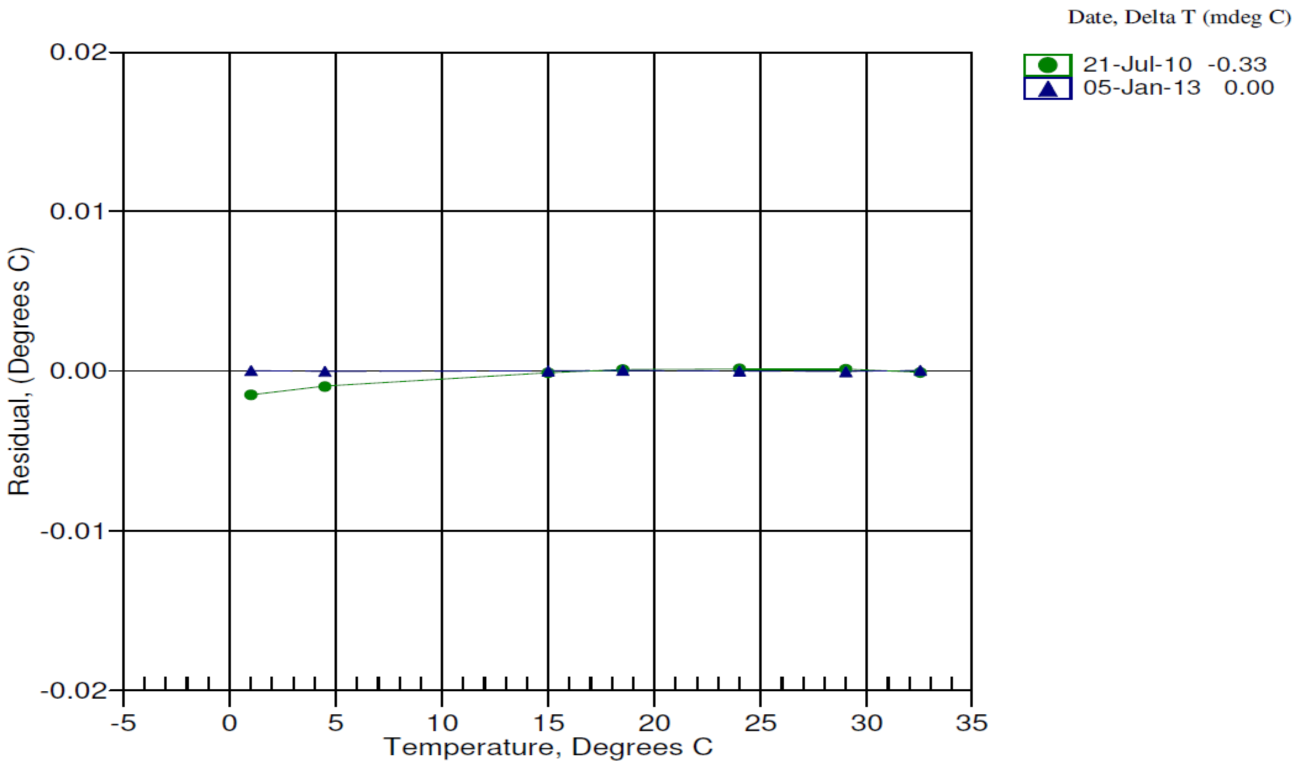
ITS-90 COEFFICIENTS

a0 = 3.183681e-005
a1 = 2.709045e-004
a2 = -2.251784e-006
a3 = 1.451990e-007

BATH TEMP (ITS-90)	INSTRUMENT OUTPUT	INST TEMP (ITS-90)	RESIDUAL (ITS-90)
0.9999	759575.7	0.9999	0.0000
4.4999	647924.4	4.4999	-0.0000
14.9999	410156.4	14.9999	0.0000
18.5000	354385.8	18.5000	0.0000
24.0000	283362.3	24.0000	-0.0000
29.0000	232647.0	29.0000	-0.0000
32.5000	203327.4	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



Thermosalinograph (conductivity) - Primary

Sea-Bird Electronics, Inc.

13431 NE 20th Street, Bellevue, WA 98005-2010 USA

Phone: (+1) 425-643-9866 Fax (+1) 425-643-9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 0243
CALIBRATION DATE: 05-Jan-13

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

COEFFICIENTS:

```
g = -1.006770e+000        CPcor = -9.5700e-008
h =  1.568761e-001        CTcor =  3.2500e-006
i = -2.378281e-004        WBOTC =  1.1173e-006
j =  4.479479e-005
```

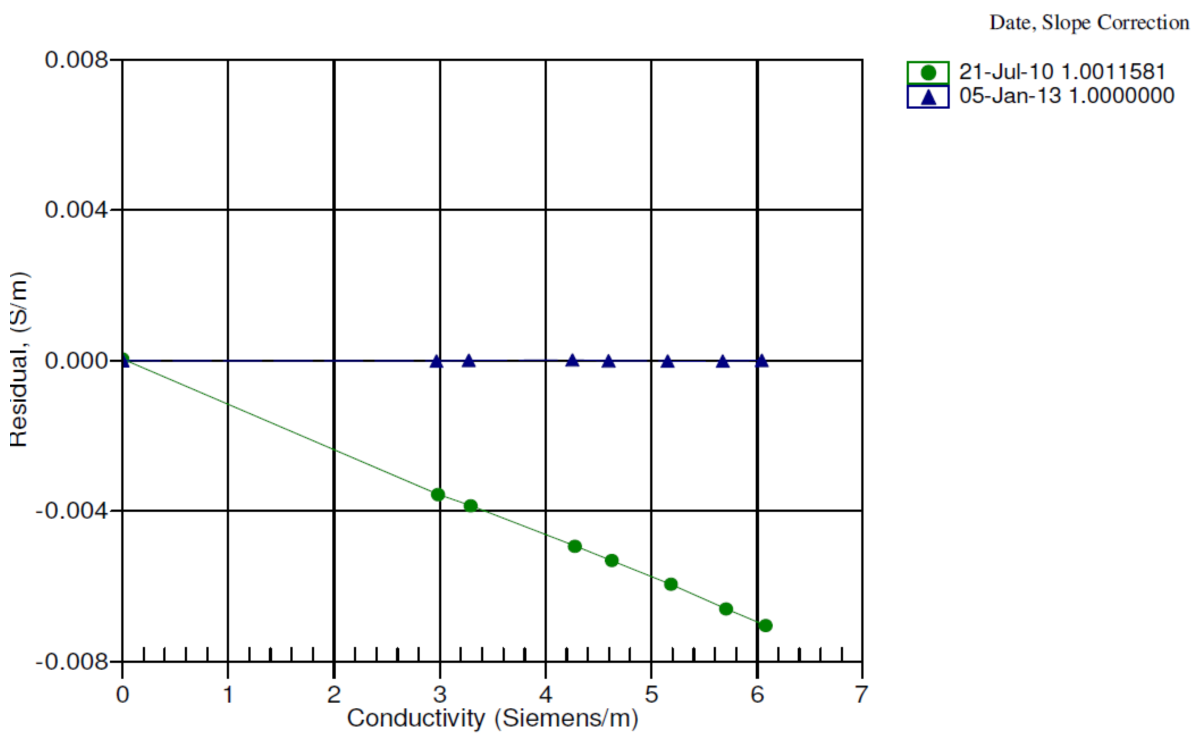
BATH TEMP (ITS-90)	BATH SAL (PSU)	BATH COND (Siemens/m)	INST FREQ (Hz)	INST COND (Siemens/m)	RESIDUAL (Siemens/m)
22.0000	0.0000	0.00000	2535.82	0.00000	0.00000
0.9999	34.7023	2.96714	5034.03	2.96713	-0.00001
4.4999	34.6821	3.27330	5223.68	3.27331	0.00001
14.9999	34.6389	4.25214	5787.67	4.25215	0.00002
18.5000	34.6290	4.59620	5972.98	4.59619	-0.00000
24.0000	34.6172	5.15227	6260.62	5.15226	-0.00001
29.0000	34.6089	5.67216	6517.74	5.67215	-0.00001
32.5000	34.6011	6.04269	6694.80	6.04271	0.00001

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



Thermosalinograph (Temp) – Secondary

Sea-Bird Electronics, Inc.
13431 NE 20th Street, Bellevue, WA 98005-2010 USA
Phone: (+1) 425-643-9866 Fax (+1) 425-643-9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 0390
CALIBRATION DATE: 09-Apr-13

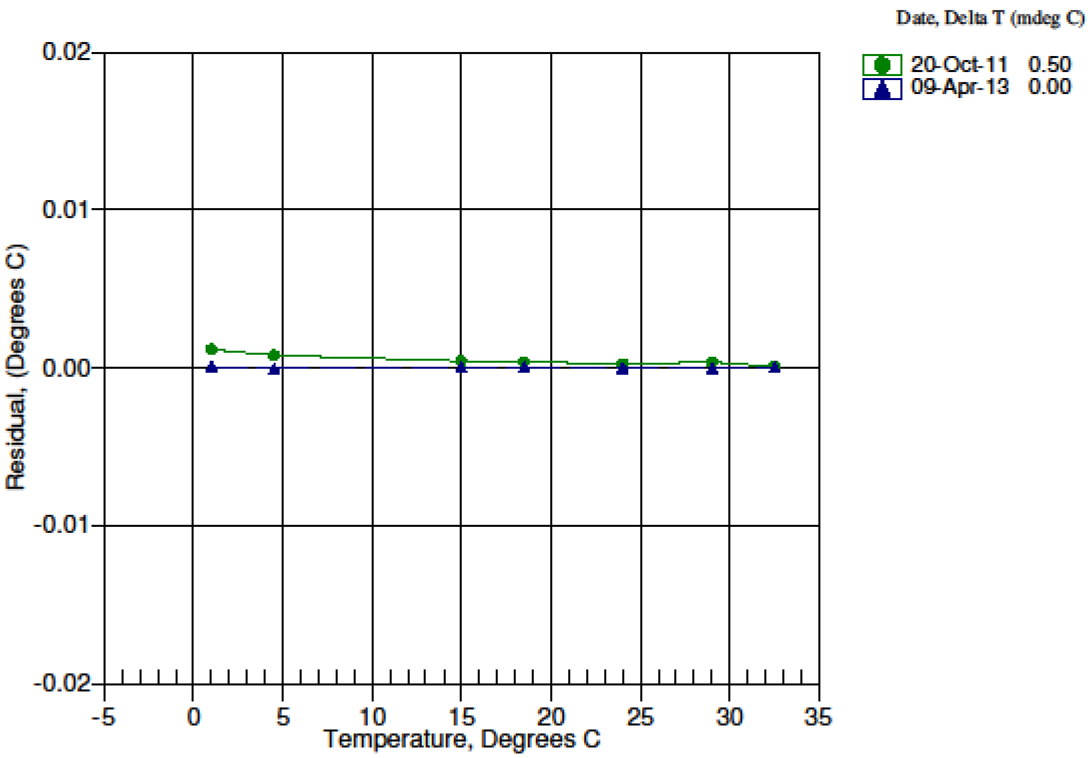
SBE 45 TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

ITS-90 COEFFICIENTS
a0 = 3.920979e-005
a1 = 2.752051e-004
a2 = -2.502164e-006
a3 = 1.533429e-007

BATH TEMP (ITS-90)	INSTRUMENT OUTPUT	INST TEMP (ITS-90)	RESIDUAL (ITS-90)
1.0000	662299.5	1.0000	0.0000
4.5000	565253.2	4.4999	-0.0001
15.0000	358382.9	15.0000	0.0000
18.5000	309810.8	18.5000	0.0000
24.0000	247914.2	24.0000	-0.0000
29.0000	203685.2	28.9999	-0.0001
32.5000	178101.0	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



Thermosalinograph (Conductivity) – Secondary

Sea-Bird Electronics, Inc.

13431 NE 20th Street, Bellevue, WA 98005-2010 USA

Phone: (+1) 425-643-9866 Fax (+1) 425-643-9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 0390
CALIBRATION DATE: 09-Apr-13

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

COEFFICIENTS:

g = -9.858436e-001
h = 1.452874e-001
i = -3.922347e-004
j = 5.265154e-005

CPcor = -9.5700e-008
CTcor = 3.2500e-006
WBOTC = 2.8724e-007

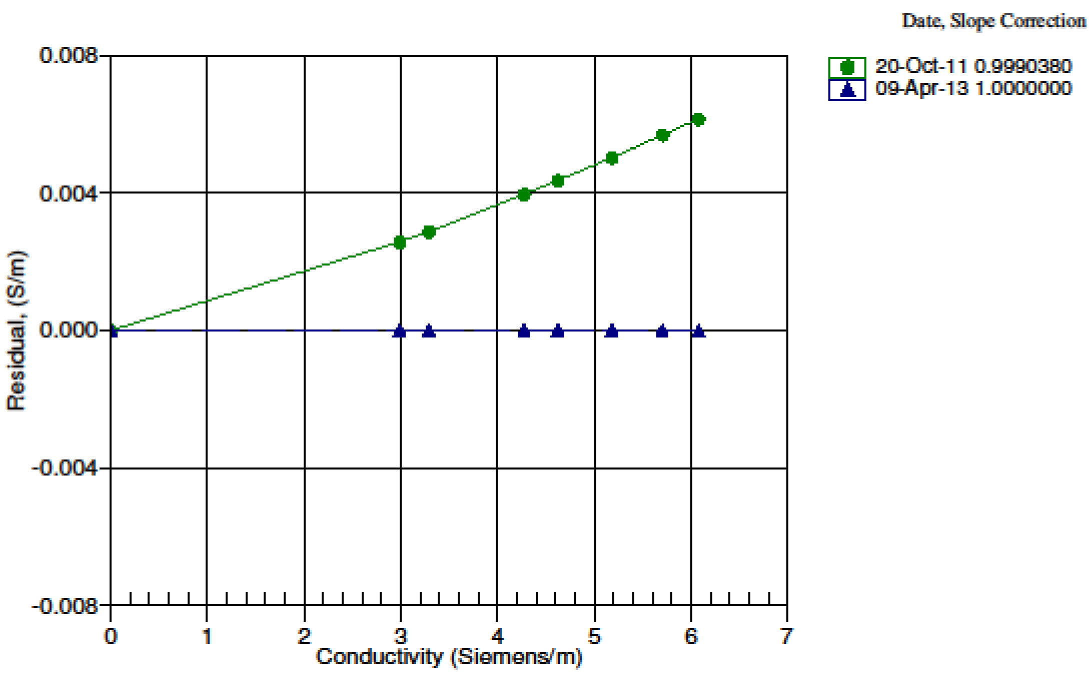
BATH TEMP (ITS-90)	BATH SAL (PSU)	BATH COND (Siemens/m)	INST FREQ (Hz)	INST COND (Siemens/m)	RESIDUAL (Siemens/m)
22.0000	0.0000	0.00000	2610.87	0.00000	0.00000
1.0000	34.9022	2.98261	5237.34	2.98261	0.00000
4.5000	34.8785	3.29001	5435.79	3.29001	-0.00000
15.0000	34.8306	4.27318	6025.91	4.27318	0.00000
18.5000	34.8211	4.61894	6219.82	4.61894	-0.00000
24.0000	34.8109	5.17791	6520.77	5.17792	0.00001
29.0000	34.8054	5.70073	6789.79	5.70072	-0.00001
32.5000	34.8011	6.07364	6975.11	6.07364	0.00000

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

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

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

Residual = instrument conductivity - bath conductivity



Transmissometer

PO Box 518
620 Applegate St.
Philomath, OR 97370

WET Labs

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

C-Star Calibration

Date October 1, 2012 S/N# CST-553DR Pathlength 25cm

	Analog output
V_d	0.060 V
V_{air}	4.797 V
V_{ref}	4.705 V

Temperature of calibration water	20.0 °C
Ambient temperature during calibration	21.6 °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 M 7/26/11

Fluorometer

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: 8/23/2012 S/N: FLRTD-380

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	0.110	0.063	0.039 V	76 counts
Scale Factor (SF)	7	13	26 µg/l/V	0.0077 µg/l/count
Maximum Output	4.97	4.97	4.97 V	16326 counts
Resolution	0.8	0.8	0.8 mV	0.9 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-380.xls Revision J 3/17/08

Temperature/Relative Humidity

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

COPY

CALIBRATION REPORT
Temperature

Customer: *Lockheed Martin Maritime Systems & Sensors*

Test Number: 2068-09T
Test Date: 7 December 2012

Customer PO: 4900028658
Sales Order: 3025

Test Sensor:
Model: 41372LC
Serial Number: *TS06133*
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)
-49.81	4.023	-49.79
0.03	12.004	0.02
50.02	20.003	50.02

(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	8006-115	204365
Brooklyn Thermometer Model 22332 D5 FC	25071	249763
Brooklyn Thermometer Model 2X400 D7-FC	77532	228060
Keithley Multimeter Model 191	15232	234027

Tested By: E Chemmeny

METEOROLOGICAL INSTRUMENTS
Tel: 231-946-3980 Fax: 231-946-4772 E-mail: met.sales@youngusa.com Website: youngusa.com
ISO 9001:2008 CERTIFIED

Barometer

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

CALIBRATION REPORT

Barometric Pressure

Customer: *Lockheed Martin Maritime Systems & Sensors*

Test Number: 2024-01P
Test Date: 24 October 2012

Customer PO: 4900022920
Sales Order: 2829

Test Sensor:
Model: 61201 Serial Number: *BP00873*
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	0	800.0
875.0	1251	875.1
950.0	2501	950.1
1025.0	3750	1025.0
1100.0	4997	1099.8

(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	4865407	234027

Tested By:

METEOROLOGICAL INSTRUMENTS
Tel: 231-946-3980 Fax: 231-946-4772 E-mail: met.sales@youngusa.com Website: youngusa.com
ISO 9001:2008 CERTIFIED

Digital Remote Temperature

Sea-Bird Electronics, Inc.
13431 NE 20th Street, Bellevue, WA 98005-2010 USA
Phone: (+1) 425-643-9866 Fax (+1) 425-643-9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 0390
CALIBRATION DATE: 15-Nov-12

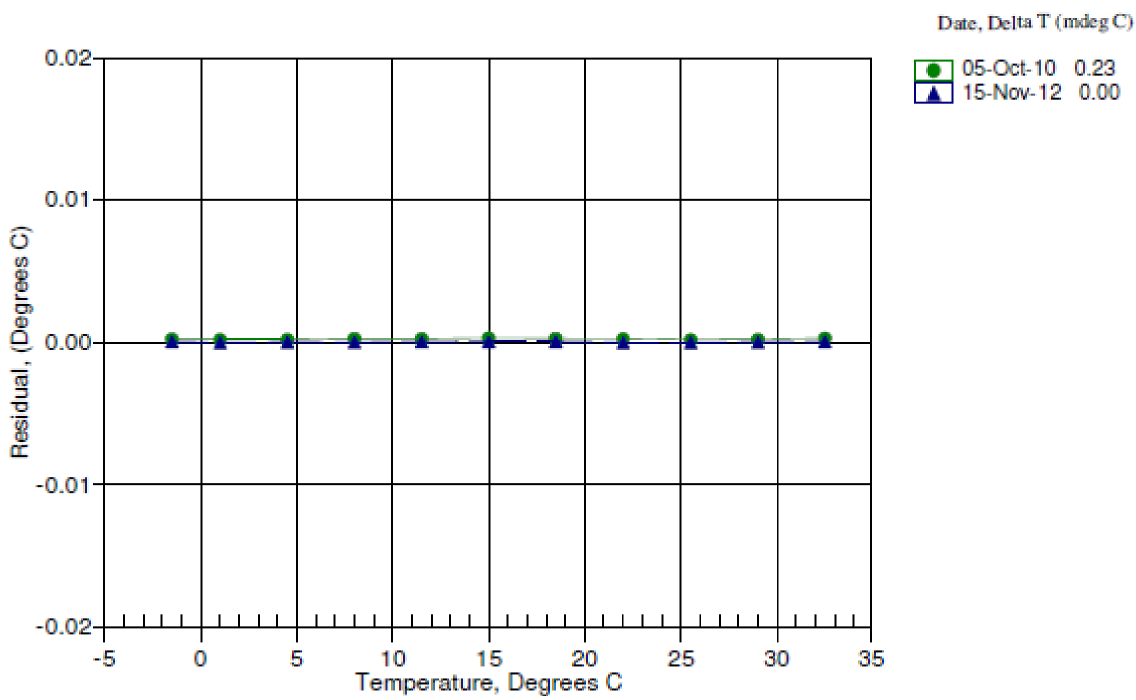
SBE 38 TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

ITS-90 COEFFICIENTS
a0 = 1.162380e-005
a1 = 2.704240e-004
a2 = -2.211322e-006
a3 = 1.429692e-007

BATH TEMP (ITS-90)	INSTRUMENT OUTPUT	INST TEMP (ITS-90)	RESIDUAL (ITS-90)
-1.50000	929104.8	-1.49997	0.00003
1.00000	827621.3	0.99997	-0.00003
4.50000	705969.8	4.49999	-0.00001
8.00000	604224.3	7.99998	-0.00002
11.50000	518828.7	11.50002	0.00002
15.00000	446914.1	15.00003	0.00003
18.50000	386152.4	18.50003	0.00003
22.00000	334650.2	21.99997	-0.00003
25.50000	290858.8	25.49997	-0.00003
29.00000	253511.5	28.99999	-0.00001
32.50000	221566.3	32.50002	0.00002

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

Residual = instrument temperature - bath temperature



PAR (mast)

Biospherical Instruments Inc.

CALIBRATION CERTIFICATE

Calibration Date	10/4/2012
Model Number	QSR-240
Serial Number	5393
Operator	TPC
Standard Lamp	V-030(3/7/12)
Probe Excitation Voltage Range:	6 to 15 VDC(+)
Output Polarity:	Positive

Probe Conditions at Calibration(in air):

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

Probe Output Voltage:

Probe Illuminated	103.6	mV
Probe Dark	0.4	mV
Probe Net Response	103.2	mV
RG780	0.4	mV

Corrected Lamp Output:

Output In Air (same condition as calibration):

9.826E+15	quanta/cm²sec
0.01632	uE/cm²sec

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

Dry:	1.0503E-17	V/(quanta/cm²sec)
	6.3248E+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

GUV

Biospherical Instruments Inc.

GUV-2511 Calibration Certificate

System Serial Number	25110805126	Date of Calibration	1/28/2013
Calibration database	25110805126v6.mdb	Date of Certificate	1/28/2013
DASSN	0109	Standard of Spectral Irradiance	V-030(3/7/12)
Microprocessor Tag Number	2	Operator	TC

Monochromatic Channels	Address	Wavelength [nm]	Responsivity [Amps per $\mu W/(cm^2 \cdot nm)$]	ScaleSmall [Volts per $\mu W/(cm^2 \cdot nm)$]	ScaleMedium [Volts per $\mu W/(cm^2 \cdot nm)$]	ScaleLarge [Volts per $\mu W/(cm^2 \cdot nm)$]	OffsetSmall [volts]	OffsetMedium [volts]	OffsetLarge [volts]	Measurement Units
Ed0305	2	305	4.4500E-11	4.5754E-06	1.3370E-03	4.0708E-01	-6.8000E-05	-6.3000E-05	1.0640E-03	$\mu W/(cm^2 nm)$
Ed0313	6	313	2.5400E-10	2.5932E-05	7.5812E-03	2.6681E+00	-9.9000E-05	-9.8000E-05	1.0000E-03	$\mu W/(cm^2 nm)$
Ed0320	8	320	2.6328E-10	2.6795E-05	7.8752E-03	2.7260E+00	-2.7200E-04	-2.7000E-04	4.5500E-04	$\mu W/(cm^2 nm)$
Ed0340	10	340	1.9883E-10	2.0246E-05	5.9348E-03	2.0975E+00	-9.8000E-05	-9.6000E-05	1.0300E-03	$\mu W/(cm^2 nm)$
Ed0380	12	380	7.3083E-11	7.4471E-06	2.1731E-03	7.6285E-01	-4.0300E-04	-3.9900E-04	2.9700E-04	$\mu W/(cm^2 nm)$
Ed0395	13	395	2.9936E-10	3.0612E-05	8.9890E-03	3.1268E+00	5.2000E-05	5.1000E-05	1.2340E-03	$\mu W/(cm^2 nm)$

Broadband Channels	Address	Wavelength [nm]	Responsivity [Amps per $\mu E/(cm^2 \cdot s)$]	ScaleSmall [Volts per $\mu E/(cm^2 \cdot s)$]	ScaleMedium [Volts per $\mu E/(cm^2 \cdot s)$]	ScaleLarge [Volts per $\mu E/(cm^2 \cdot s)$]	OffsetSmall [volts]	OffsetMedium [volts]	OffsetLarge [volts]	Measurement Units
Ed0PAR	18	400-700	1.6923E-05	1.7238E+00	5.0511E+02	1.7681E+05	-1.6000E-05	-1.4000E-05	1.5630E-03	$\mu E/(cm^2 sec)$

Auxiliary 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

PIR

EPLAB

THE EPPLEY LABORATORY, INC.

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

STANDARDIZATION OF EPPLEY PRECISION INFRARED RADIOMETER Model PIR

Serial Number: 28903F3

Resistance: 675 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 average 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:

3.55×10^{-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 Practical Temperature Scale (IPTS) through a precision low-temperature blackbody.

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

Shipped to: LMP4 ISGS (NSF)
Port Hueneme, CA

S.O. Number: 63658
Date: January 7, 2013

Remarks:

Date of Test: December 14, 2012

In Charge of Test: Debra L. Gienty

Reviewed by: Thomas D. Kirk

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 Email: info@eppleylab.com

STANDARDIZATION OF EPPLEY PRECISION SPECTRAL PYRANOMETER Model PSP

Serial Number: 28933F3

Resistance: 686 Ω at 23°C
Temperature Compensation Range: -20° to +40°C

This radiometer has been compared with Standard Precision Spectral 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 sensitivity of:

$$8.27 \times 10^{-6} \text{ volts/watts meter}^{-2}$$

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 Internationale des Unites (SI units), which participated in the Eleventh International Pyrheliometric Comparisons (IPC XI) at Davos, Switzerland in September-October 2010.

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

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: LMP4 ISGS (NSG)
Port Hueneme, CA

S.O. Number: 63658
Date: January 7, 2013

Date of Test: December 20, 2012

In Charge of Test:

Reviewed by:

Remarks: Sensitivity before repainting element = 7.81 x 10^{-6} volts/watts meter^{-2}

CTD Calibration Sheets

Primary Temperature

Sea-Bird Electronics, Inc.
13431 NE 20th Street, Bellevue, WA 98005-2010 USA
Phone: (+1) 425-643-9866 Fax (+1) 425-643-9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 5034
CALIBRATION DATE: 11-Sep-12

SBE3 TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

ITS-90 COEFFICIENTS
g = 4.33933090e-003
h = 6.35575182e-004
i = 2.09876477e-005
j = 1.85215961e-006
f0 = 1000.0

IPTS-68 COEFFICIENTS
a = 3.68121169e-003
b = 5.97177236e-004
c = 1.50708339e-005
d = 1.85356937e-006
f0 = 2914.493

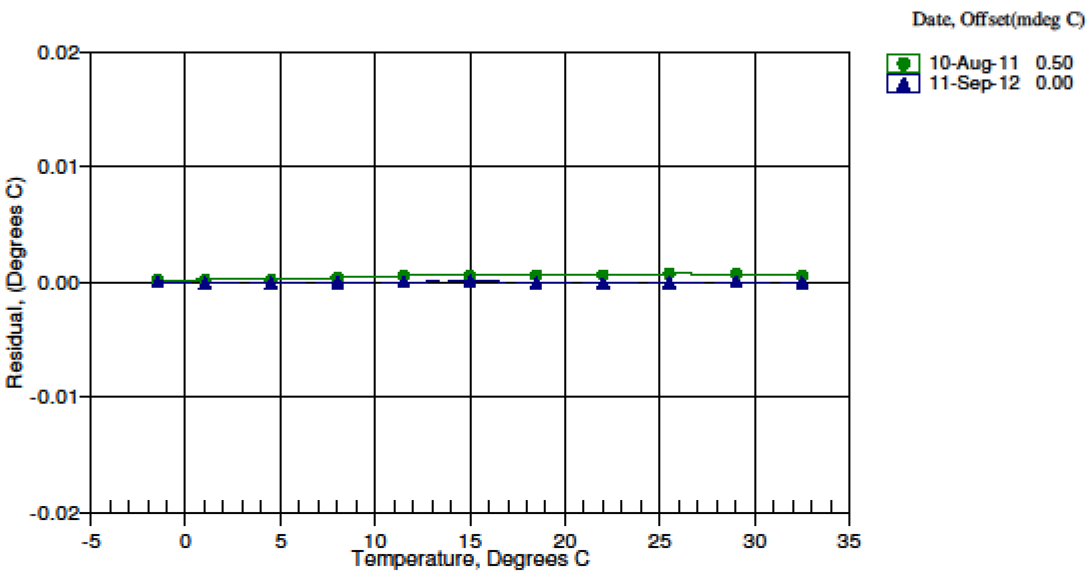
BATH TEMP (ITS-90)	INSTRUMENT FREQ (Hz)	INST TEMP (ITS-90)	RESIDUAL (ITS-90)
-1.5000	2914.493	-1.5000	0.00005
1.0000	3083.298	0.9999	-0.00006
4.5000	3331.360	4.5000	-0.00003
8.0000	3593.454	8.0000	-0.00000
11.5000	3869.964	11.5000	0.00002
14.9999	4161.260	15.0000	0.00010
18.5000	4467.707	18.5000	-0.00003
22.0000	4789.657	21.9999	-0.00008
25.5000	5127.463	25.5000	-0.00001
29.0000	5481.440	29.0000	0.00004
32.5000	5851.897	32.5000	-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



Secondary Temperature

Sea-Bird Electronics, Inc.
13431 NE 20th Street, Bellevue, WA 98005-2010 USA
Phone: (+1) 425-643-9866 Fax (+1) 425-643-9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 2658
CALIBRATION DATE: 11-Sep-12

SBE3 TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

ITS-90 COEFFICIENTS
g = 4.31194611e-003
h = 6.39735426e-004
i = 2.23720401e-005
j = 2.06039887e-006
f0 = 1000.0

IPTS-68 COEFFICIENTS
a = 3.68121177e-003
b = 6.00710643e-004
c = 1.61018866e-005
d = 2.06192251e-006
f0 = 2769.957

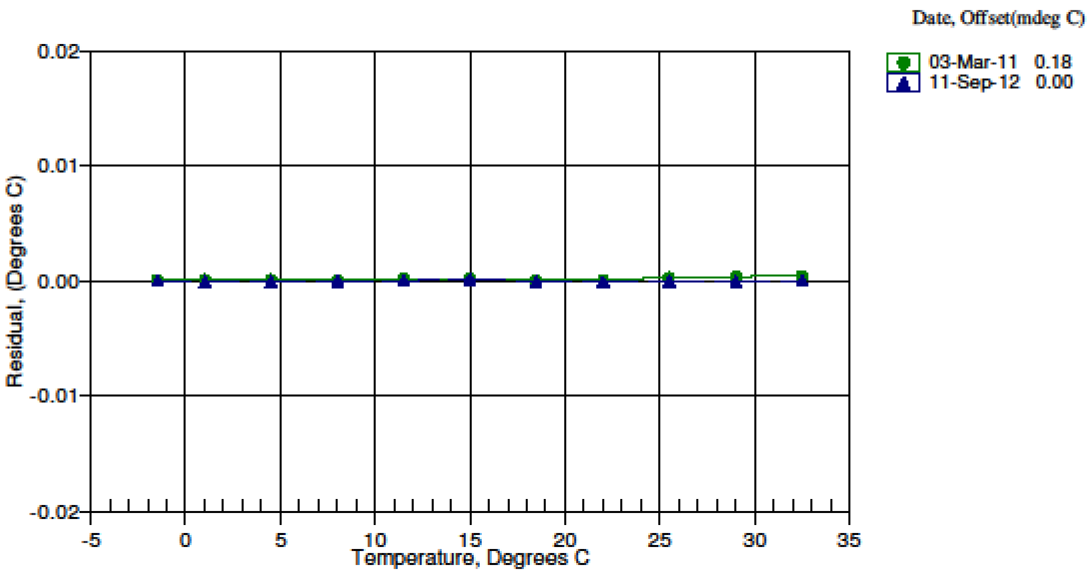
BATH TEMP (ITS-90)	INSTRUMENT FREQ (Hz)	INST TEMP (ITS-90)	RESIDUAL (ITS-90)
-1.5000	2769.957	-1.5000	0.00004
1.0000	2929.435	1.0000	-0.00003
4.5000	3163.739	4.5000	-0.00004
8.0000	3411.245	8.0000	-0.00002
11.5000	3672.310	11.5000	0.00001
14.9999	3947.284	15.0000	0.00014
18.5000	4236.499	18.5000	-0.00003
22.0000	4540.292	21.9999	-0.00008
25.5000	4858.992	25.5000	-0.00000
29.0000	5192.886	29.0000	-0.00001
32.5000	5542.279	32.5000	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



Primary Conductivity

Sea-Bird Electronics, Inc.
13431 NE 20th Street, Bellevue, WA 98005-2010 USA
Phone: (+1) 425-643-9866 Fax (+1) 425-643-9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 2247
CALIBRATION DATE: 11-Sep-12

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

GHIJ COEFFICIENTS
g = -1.03553165e+001
h = 1.37314660e+000
i = -2.00256634e-003
j = 2.13614082e-004
CPcor = -9.5700e-008 (nominal)
CTcor = 3.2500e-006 (nominal)

ABCDM COEFFICIENTS
a = 5.98645844e-007
b = 1.36751618e+000
c = -1.03421746e+001
d = -7.86091299e-005
m = 6.1
CPcor = -9.5700e-008 (nominal)

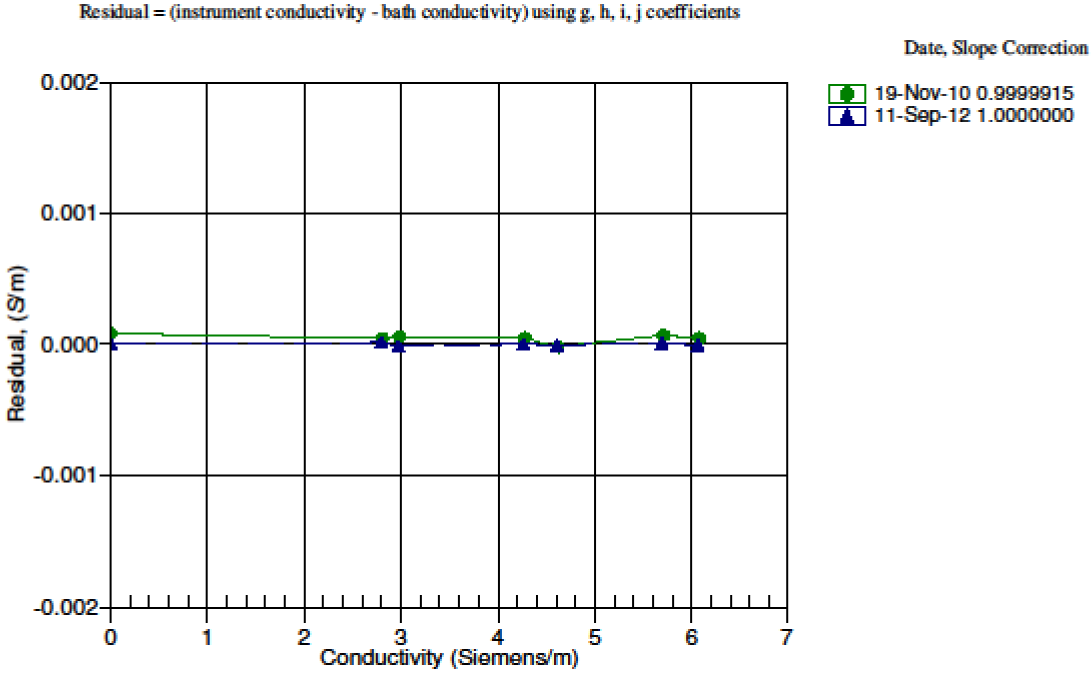
BATH TEMP (ITS-90)	BATH SAL (PSU)	BATH COND (Siemens/m)	INST FREQ (kHz)	INST COND (Siemens/m)	RESIDUAL (Siemens/m)
0.0000	0.0000	0.00000	2.75004	0.00000	0.00000
-1.0000	34.7322	2.79843	5.29294	2.79845	0.00001
1.0000	34.7334	2.96955	5.40970	2.96954	-0.00001
15.0000	34.7346	4.26265	6.22124	4.26265	0.00000
18.5000	34.7346	4.60870	6.42090	4.60869	-0.00000
29.0001	34.7303	5.68983	7.00774	5.68984	0.00001
32.5001	34.7194	6.06101	7.19804	6.06100	-0.00001

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

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

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

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



Secondary Conductivity

Sea-Bird Electronics, Inc.

13431 NE 20th Street, Bellevue, WA 98005-2010 USA
Phone: (+1) 425-643-9866 Fax (+1) 425-643-9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 2293
CALIBRATION DATE: 07-May-13

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

GHIJ COEFFICIENTS
g = -1.07086626e+001
h = 1.47932005e+000
i = -2.07266898e-003
j = 2.29492166e-004
CPcor = -9.5700e-008 (nominal)
CTcor = 3.2500e-006 (nominal)

ABCDM COEFFICIENTS
a = 6.94121819e-007
b = 1.47370551e+000
c = -1.06964400e+001
d = -8.03930484e-005
m = 6.1
CPcor = -9.5700e-008 (nominal)

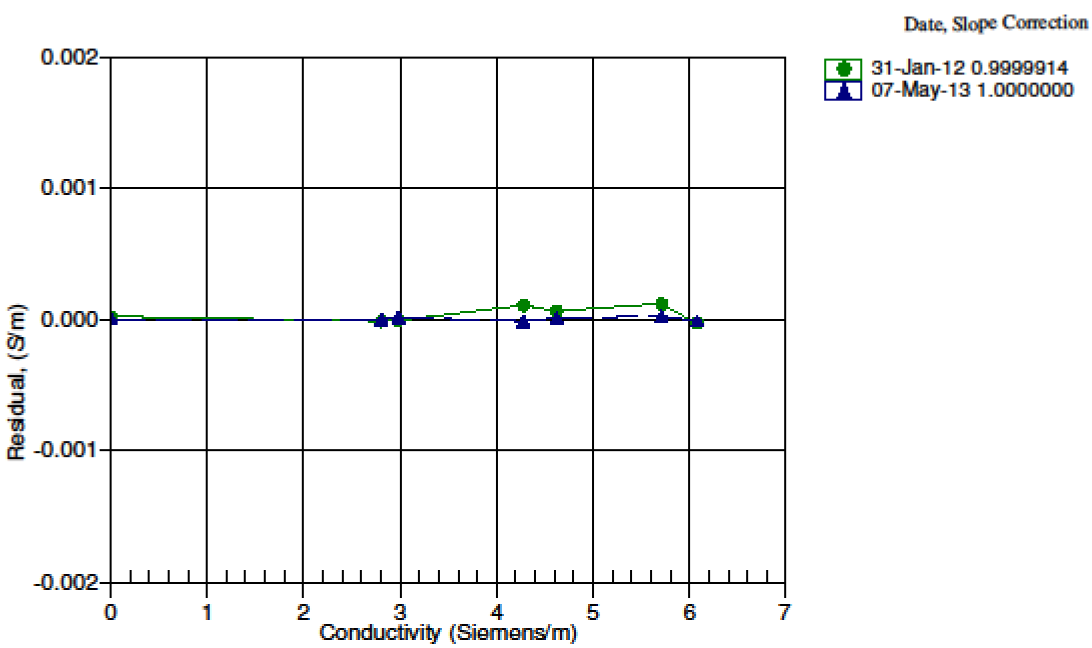
BATH TEMP (ITS-90)	BATH SAL (PSU)	BATH COND (Siemens/m)	INST FREQ (kHz)	INST COND (Siemens/m)	RESIDUAL (Siemens/m)
0.0000	0.0000	0.00000	2.69409	0.00000	0.00000
-0.9999	34.8537	2.80732	5.12811	2.80731	-0.00001
1.0001	34.8542	2.97890	5.24029	2.97892	0.00001
15.0001	34.8557	4.27594	6.02054	4.27593	-0.00002
18.5001	34.8553	4.62299	6.21261	4.62300	0.00001
29.0001	34.8539	5.70779	6.77757	5.70781	0.00002
32.5001	34.8479	6.08089	6.96114	6.08087	-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



Primary Dissolved Oxygen

Sea-Bird Electronics, Inc.
13431 NE 20th Street, Bellevue, WA 98005-2010 USA
Phone: (+1) 425-643-9866 Fax (+1) 425-643-9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 0200
CALIBRATION DATE: 07-Nov-12

SBE 43 OXYGEN CALIBRATION DATA

COEFFICIENTS

Soc = 0.4645
Voffset = -0.4932
Tau20 = 1.29

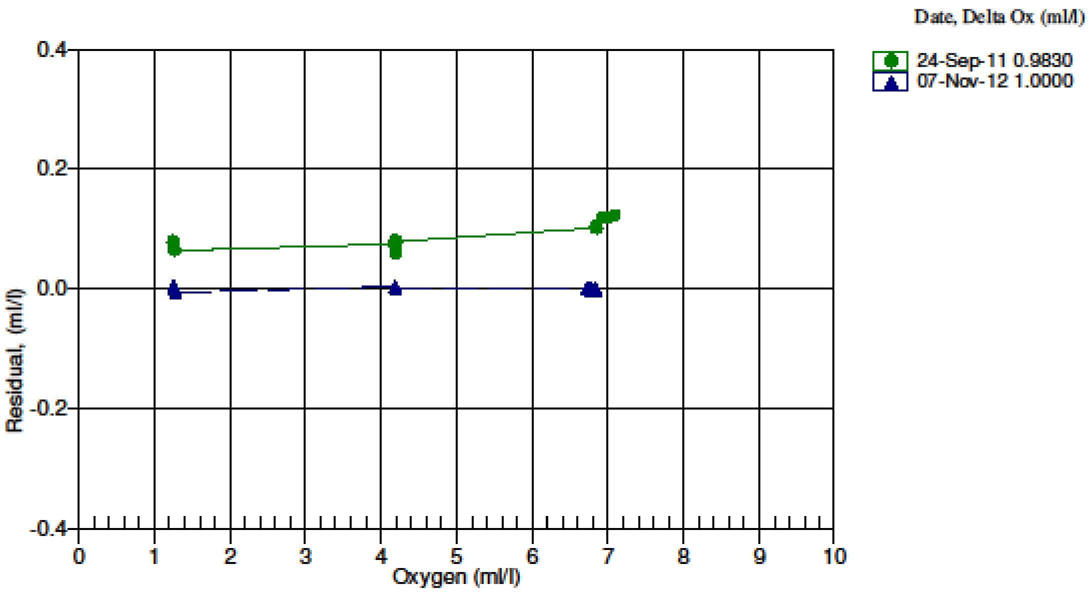
A = -3.7439e-003
B = 1.9295e-004
C = -3.0659e-006
E nominal = 0.036

NOMINAL DYNAMIC COEFFICIENTS

D1 = 1.92634e-4
D2 = -4.64803e-2
H1 = -3.30000e-2
H2 = 5.00000e+3
H3 = 1.45000e+3

BATH OX (ml/l)	BATH TEMP ITS-90	BATH SAL PSU	INSTRUMENT OUTPUT(VOLTS)	INSTRUMENT OXYGEN(ml/l)	RESIDUAL (ml/l)
1.25	6.00	0.04	0.808	1.25	0.00
1.25	2.00	0.04	0.775	1.26	0.01
1.25	12.00	0.04	0.860	1.26	0.00
1.27	20.00	0.04	0.933	1.27	-0.00
1.28	30.00	0.04	1.022	1.27	-0.01
1.28	26.00	0.04	0.986	1.27	-0.01
4.18	6.00	0.04	1.545	4.19	0.00
4.19	12.00	0.04	1.715	4.18	-0.00
4.19	2.00	0.04	1.433	4.20	0.00
4.20	30.00	0.04	2.239	4.20	-0.00
4.20	20.00	0.04	1.946	4.20	-0.00
4.20	26.00	0.04	2.120	4.20	-0.00
6.71	30.00	0.04	3.285	6.71	0.00
6.75	20.00	0.04	2.830	6.75	0.00
6.76	26.00	0.04	3.113	6.76	0.00
6.77	12.00	0.04	2.470	6.77	-0.00
6.82	6.00	0.04	2.208	6.83	0.00
6.83	2.00	0.04	2.023	6.83	-0.00

Oxygen (ml/l) = Soc * (V + Voffset) * (1.0 + A * T + B * T^2 + C * T^3) * OxSol(T,S) * exp(E * P / K)
V = voltage output from SBE43, T = temperature [deg C], S = salinity [PSU], K = temperature [Kelvin]
OxSol(T,S) = oxygen saturation [ml/l], P = pressure [dbar], Residual = instrument oxygen - bath oxygen



Secondary Dissolved Oxygen

Sea-Bird Electronics, Inc.
13431 NE 20th Street, Bellevue, WA 98005-2010 USA
Phone: (+1) 425-643-9866 Fax (+1) 425-643-9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 0196
CALIBRATION DATE: 30-Aug-12

SBE 43 OXYGEN CALIBRATION DATA

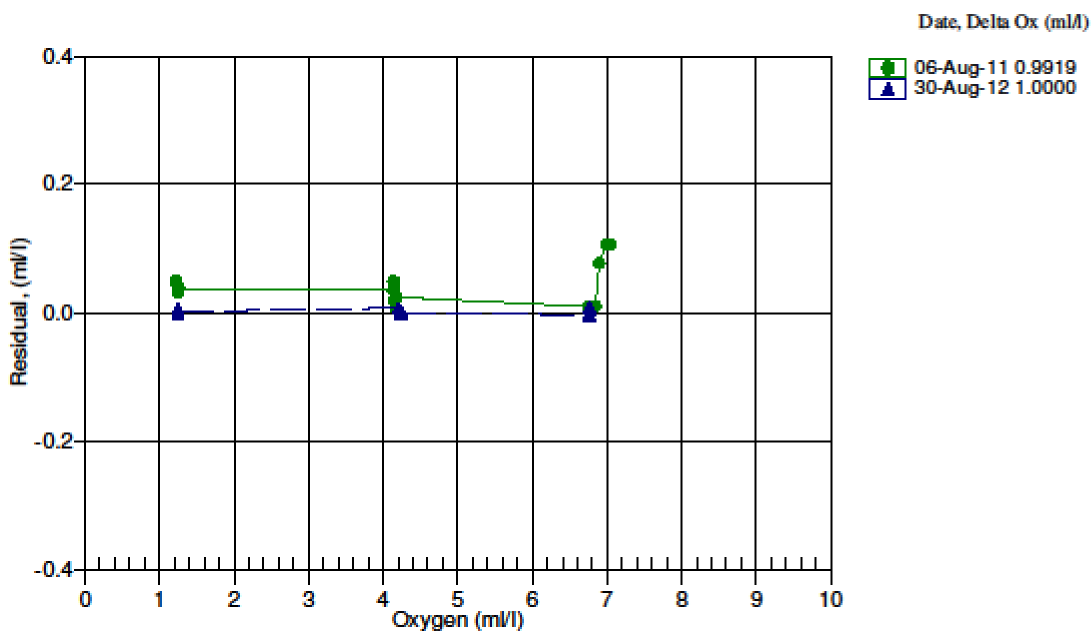
COEFFICIENTS
Soc = 0.5426
Voffset = -0.4999
Tau20 = 1.04

A = -5.1498e-003
B = 2.2483e-004
C = -1.1475e-006
E nominal = 0.036

NOMINAL DYNAMIC COEFFICIENTS
D1 = 1.92634e-4 H1 = -3.30000e-2
D2 = -4.64803e-2 H2 = 5.00000e+3
H3 = 1.45000e+3

BATH OX (ml/l)	BATH TEMP ITS-90	BATH SAL PSU	INSTRUMENT OUTPUT(VOLTS)	INSTRUMENT OXYGEN(ml/l)	RESIDUAL (ml/l)
1.24	2.00	0.05	0.738	1.24	-0.00
1.24	6.00	0.05	0.769	1.24	-0.00
1.25	12.00	0.05	0.814	1.24	-0.00
1.25	26.00	0.04	0.908	1.25	0.01
1.25	20.00	0.04	0.870	1.25	0.00
4.21	26.00	0.04	1.871	4.21	0.01
4.23	20.00	0.04	1.752	4.23	-0.00
4.24	12.00	0.05	1.569	4.23	-0.00
4.24	6.00	0.05	1.419	4.24	0.00
4.24	2.00	0.05	1.315	4.24	-0.00
6.74	12.00	0.05	2.201	6.74	-0.00
6.75	2.00	0.05	1.797	6.74	-0.00
6.75	20.00	0.04	2.499	6.74	-0.00
6.75	6.00	0.05	1.964	6.76	0.01
6.76	30.00	0.04	2.816	6.76	-0.00
6.78	26.00	0.05	2.709	6.79	0.00

Oxygen (ml/l) = Soc * (V + Voffset) * (1.0 + A * T + B * T^2 + C * T^3) * OxSol(T,S) * exp(E * P / K)
V = voltage output from SBE43, T = temperature [deg C], S = salinity [PSU], K = temperature [Kelvin]
OxSol(T,S) = oxygen saturation [ml/l], P = pressure [dbar], Residual = instrument oxygen - bath oxygen



Fluorometer

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: 3/21/2013 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	0.100	0.055	0.034 V	70 counts
Scale Factor (SF)	6	13	26 µg/l/V	0.0079 µg/l/count
Maximum Output	4.96	4.96	4.96 V	16330 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-399 Revision J 3/17/08

Transmissometer

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 September 17, 2012 S/N# CST-248DR Pathlength 25cm

	Analog output
V_d	0.059 V
V_{air}	4.744 V
V_{ref}	4.631 V

Temperature of calibration water	20.1 °C
Ambient temperature during calibration	20.8 °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 M 7/26/11

PAR

Biospherical Instruments Inc

CALIBRATION CERTIF CATE

UNDERWATER PAR SENSOR WITH LOG AMPLIFIER

Calibration Date: 01/23/13 **Job No.:** R11517
Model Number: QSP200L4S
Serial Number: 4581
Operator: TPC
Standard Lamp: V 030(3/7/12)
Operating Voltage Range: 6 to 15 VDC (+)

Note: The QSP-200 uses a log amplifier to measure the detector signal current with V = log I (Amps) / IRef
To calculate irradiance, use this formula:

Irradiance = Calibration factor * (10^Light Signal Voltage - 10^Dark Voltage)

With the appropriate (solar corrected) Irradiance Calibration Factor:

Dry Calibration Factor:	**1.54E+13**	**quanta/cm²·sec/"amps"**	**2.56E-05**	**µEinsteins/cm²·sec/"amps"**
Wet Calibration Factor:	**2.73E+13**	**quanta/cm²·sec/"amps"**	**4.53E-05**	**µEinsteins/cm²·sec/"amps"**

Sensor Test Data and Results[4]

Sensor Supply Current (Dark):	68.5	mA			
Supply Voltage:	6	Volts			
Lamp Integrated PAR Irradiance:	5.83E+15	quanta/cm² sec	0.01632	µEinsteins/cm²sec	
SC3 Immersion Coefficient:	0.5664	Scalar Correction:	1	PAR Solar Correction:	1.0000

Nominal Filter OD	Calibrated Trans.	Sensor Voltage	Measured Trans.		Measured Signal (Amps)	Estimated Signal (Amps)	Calc. Output (Volts)	Error (Volts)	Error (%)	Test Irrad. (quanta/cm² sec)
No Filter	100.00%	2.805	100.00%		6.38E-08	6.38E-08	2.806	0.001	0.0	9.83E+15
0.3	36.10%	2.365	36.19%		2.31E-08	2.30E-08	2.365	0.000	-0.2	3.56E+15
0.5	27.80%	2.252	27.81%		1.77E-08	1.76E-08	2.249	-0.002	-0.6	2.73E+15
1	9.27%	1.786	9.37%		5.98E-09	5.91E-09	1.782	-0.004	-1.1	9.21E+14
2	1.11%	0.530	1.11%		7.08E-10	7.08E-10	0.931	0.001	0.0	1.09E+14
3	0.05%	0.282	0.07%		4.65E-11	3.41E-11	0.253	-0.029	-26.7	7.16E+12

Dark Before 0.162 Volts
Light - No Filter Hldr. 2.809 Volts
Dark After - NFH. 0.161 Volts
Average Dark 0.162 Volts

I_{ref} = 1.00E-10 Amps
I_{Dark} = 1.45E-10 Amps
10^{VDark} = 1.450441 Amps

RG780 0.22

Notes:
1. Annual calibration is recommended.
2. There is increasing error associated with readings below zero.
3. The collector should be cleaned frequently with alcohol.
4) This section is for internal use and for more advanced analysis.

QSP-200L.QSP2300(2006-).xls

Mocness Calibration Sheets

Temperature

Sea-Bird Electronics, Inc.
13431 NE 20th Street, Bellevue, WA 98005-2010 USA
Phone: (+1) 425-643-9866 Fax (+1) 425-643-9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 1619
CALIBRATION DATE: 21-Feb-12

SBE3 TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

ITS-90 COEFFICIENTS
g = 4.80789855e-003
h = 6.83283757e-004
i = 3.08629771e-005
j = 2.86954367e-006
f0 = 1000.0

IPTS-68 COEFFICIENTS
a = 3.68121369e-003
b = 6.01245812e-004
c = 1.56808923e-005
d = 2.87114323e-006
f0 = 5851.894

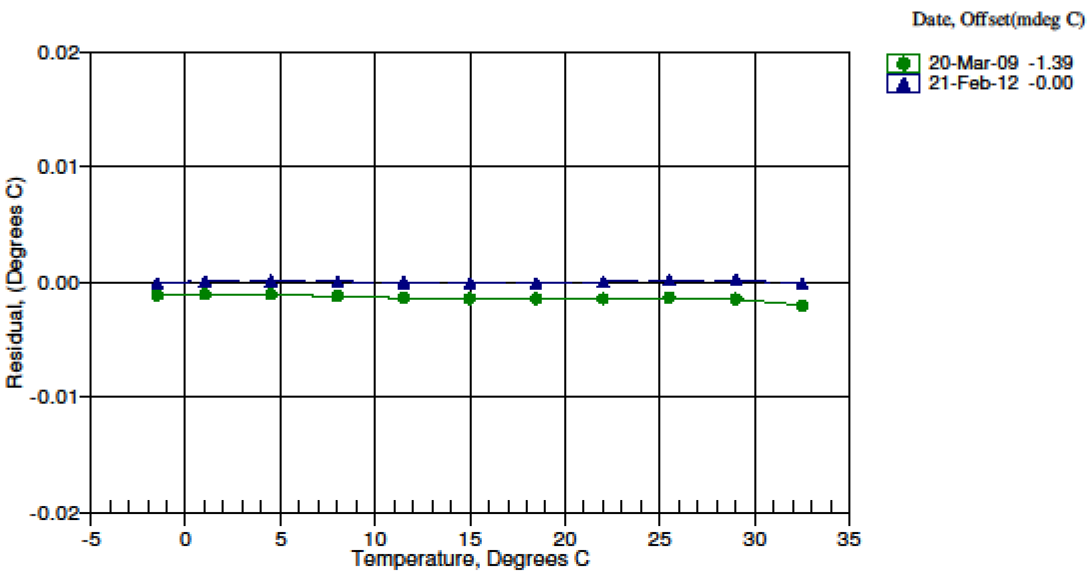
BATH TEMP (ITS-90)	INSTRUMENT FREQ (Hz)	INST TEMP (ITS-90)	RESIDUAL (ITS-90)
-1.5000	5851.894	-1.5001	-0.00010
1.0000	6188.522	1.0001	0.00007
4.5000	6682.955	4.5001	0.00013
8.0000	7205.069	8.0000	0.00003
11.5000	7755.600	11.5000	-0.00004
15.0000	8335.226	14.9999	-0.00012
18.5000	8944.617	18.4999	-0.00014
22.0000	9584.422	22.0000	0.00001
25.5000	10255.213	25.5002	0.00016
29.0000	10957.535	29.0002	0.00018
32.5000	11691.867	32.4998	-0.00018

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



Conductivity

Sea-Bird Electronics, Inc.
13431 NE 20th Street, Bellevue, WA 98005-2010 USA
Phone: (+1) 425-643-9866 Fax (+1) 425-643-9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 2048
CALIBRATION DATE: 31-Jan-12

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

GHIJ COEFFICIENTS
g = -1.03097271e+001
h = 1.43374069e+000
i = -5.58350331e-003
j = 6.10102329e-004
CPcor = -9.5700e-008 (nominal)
CTcor = 3.2500e-006 (nominal)

ABCDM COEFFICIENTS
a = 1.50720900e-006
b = 1.41845153e+000
c = -1.02760376e+001
d = -7.77295962e-005
m = 6.2
CPcor = -9.5700e-008 (nominal)

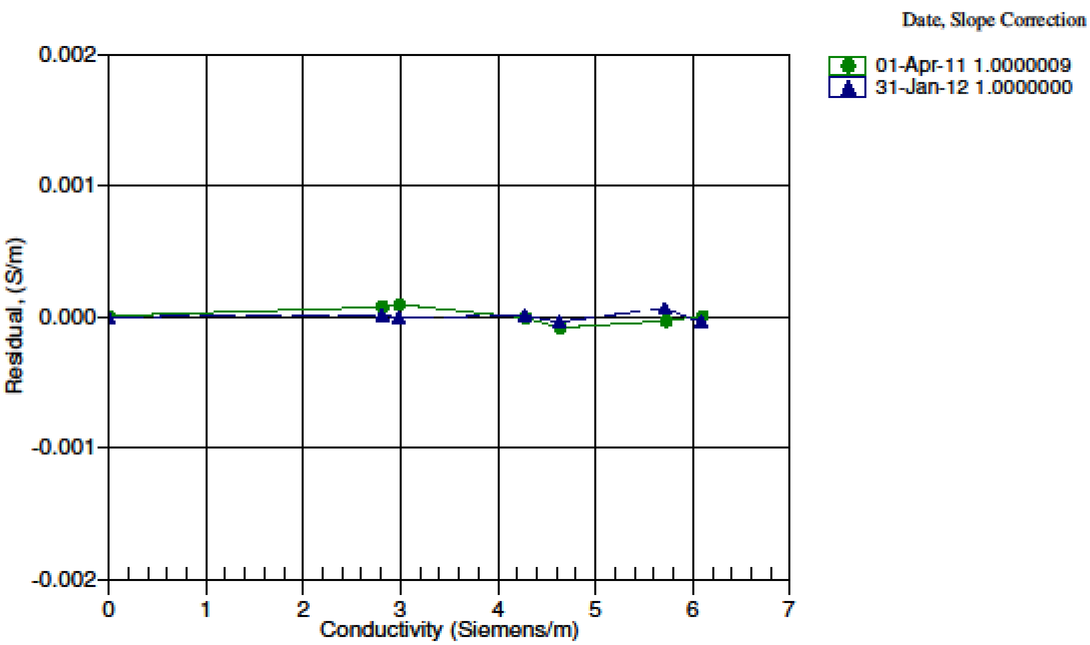
BATH TEMP (ITS-90)	BATH SAL (PSU)	BATH COND (Siemens/m)	INST FREQ (kHz)	INST COND (Siemens/m)	RESIDUAL (Siemens/m)
0.0000	0.0000	0.00000	2.69154	0.00000	0.00000
-0.9999	34.8715	2.80862	5.19774	2.80863	0.00001
1.0001	34.8719	2.98027	5.31248	2.98027	-0.00001
15.0001	34.8711	4.27763	6.10926	4.27764	0.00001
18.5001	34.8708	4.62483	6.30501	4.62479	-0.00004
29.0001	34.8688	5.70996	6.88007	5.71002	0.00006
32.5001	34.8634	6.08328	7.06665	6.08324	-0.00004

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



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.

Significant Notes

Icing impacted collection of seawater data during first several hours after departure from Palmer Station on day 265. Data end users are encouraged to visually evaluate the data prior to use.

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.
(i.e, The PCO2 system was turned off for the troubleshooting and repairs of the equilibrator pump.)

Day Of Year	Time (GMT)	Event	Location
001	08:51	Data Logging ON	@ 68W
005	10:32	Data Logging OFF	Arrive Palmer Station
006		VTG string was added to Seapath serial output.	@ PAL
007	11:13	Data Logging ON	Depart Palmer Station
018	18:34	Data Logging OFF	Arrive Rothera Station
019	10:57	Data Logging ON	Depart Rothera Station
027	15:27 – 16:02	Seapath dead	
034	10:04	Data Logging OFF	Arrive Palmer Station
035	13:00	Data Logging ON	Depart Palmer Station
038	23:43	Data Logging OFF	@ 68W