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# LMG 1302

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## Cruise Data Report

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# Table of Contents

INTRODUCTION.....	1
ARCHIVE DATA EXTRACTION .....	2
CD DIRECTORY STRUCTURE.....	3
DISTRIBUTION CONTENTS.....	4
ADCP .....	4
CALIBRATION .....	4
IMAGERY .....	4
LOGSHEETS.....	4
MAPS .....	4
DATA AND SCIENCE REPORT .....	4
SCIENCE .....	ERROR! BOOKMARK NOT DEFINED.
WAYPOINTS .....	4
QC PLOTS.....	5
JGOFS DATA SET .....	6
PCO2-MERGED DATA SET .....	7
RVDAS .....	8
<i>Meteorological and Light Data</i> .....	8
<i>Navigational Data</i> .....	8
<i>Geophysical Data</i> .....	8
<i>Oceanographic Data</i> .....	8
DATA FILE NAMES AND STRUCTURES.....	9
LKNU – KNUDSEN SONAR .....	9
LNDS – NET DEPTH SENSOR .....	10
LWN1 - WINCHES .....	10
LMWX    - CAMPBELL METEOROLOGICAL DAS .....	10
LSEA – WET WALL FLOWS, TRANSMISSOMETER .....	11
UTSG – MICROTSG, THERMOSALINOGRAPH .....	12
LRTM – DIGITAL REMOTE TEMPERATURE .....	12
LDFL – FLUOROMETER, WETLAB ECO .....	12
LGO2 – OXYGEN SYSTEM .....	12
LOXY – OXYGEN (PART OF PCO2 SYSTEM, SEPARATE FROM OXYGEN SYSTEM) .....	14
LPCO – PCO2 SYSTEM.....	14
LGUV – BIOSPHERICAL GUV .....	15
LSVP - SOUND VELOCITY PROBE IN ADCP TRANSDUCER WELL .....	16
LADC – ADCP SPEED LOG .....	16
LGYR - GYRO .....	16
LSEP – SEAPATH 330 GPS .....	17

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LGAR – GARMIN GPS .....	18
TGPS – TRIMBLE CENTURION GPS .....	19
<b>LMG SENSORS.....</b>	<b>21</b>
SHIPBOARD SENSORS .....	21
<b>UNDERWAY CALIBRATION SHEETS.....</b>	<b>22</b>
THERMOSALINOGRAPH (TEMP) – PRIMARY .....	22
THERMOSALINOGRAPH (CONDUCTIVITY) - PRIMARY .....	23
THERMOSALINOGRAPH (TEMP) – SECONDARY.....	23
THERMOSALINOGRAPH (CONDUCTIVITY) – SECONDARY .....	25
.....	25
TRANSMISSOMETER .....	25
FLUOROMETER .....	27
TEMPERATURE/RELATIVE HUMIDITY.....	28
BAROMETER .....	29
PIR.....	30
PSP .....	31
DIGITAL REMOTE TEMPERATURE .....	32
PAR (MAST) .....	33
GUV .....	34
<b>ACQUISITION AND PROCESSING INFORMATION .....</b>	<b>35</b>
PROCESSING SPECIFICS .....	35
SIGNIFICANT NOTES.....	35
ERRORS AND EVENTS .....	35

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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

<b>Disc 1</b> ADCP: ADCP.tar  Cal: InstCoef.txt UW\  Imagery: Imag.tar  Logs: airSouth.pdf airNorth.pdf  Maps: LMG1302_close.jpg LMG1302_far.jpg  Process: JGOF.tar PCO2.tar PROC.tar QC.tar  Report: Report.doc Report.pdf  rvdas: nav/ uw/  Utility: Acrobat/ Winzip/  Waypoint: Waypoint.txt		
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## 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](mailto: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 logsheets for XBT, XCTD, salts, air samples and TCO2 data. For further information on this data (TCO2), contact Tim Newberger at [tnewberg@ldeo.columbia.edu](mailto:tnewberg@ldeo.columbia.edu).

### 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.

### Data and Science Report

/Report/

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

### WAYPOINTS

/WAYPTS/

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	$\mu\text{Einsteins/meters}^2 \text{ sec}$
10	Sea surface temperature	$^{\circ}\text{C}$
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	$^{\circ}\text{C}$
17	Relative humidity	%
18	Barometric pressure	mBars
19	Sea surface fluorometry	$\mu\text{g/l}$
20	Transmissometer	Volts (0-5)
21	PSP	$\text{W/m}^2$
22	PIR	$\text{W/m}^2$

**pCO<sub>2</sub>-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 <sub>2</sub> 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 <sub>2</sub> pressure	microAtm
9	Equilibrated temperature	°C
10	Sea Water Temp	1 or 2 digits
11	Valve position	°C
12	Flow source (Equil = pCO <sub>2</sub> 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 thruster 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	Anschutz 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 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)	lfir	continuous	1 sec	Turner 10-AU-005
Fluorometry (digital)	ldfir	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	Navigation Data	File ID
Meteorological - Cambell	lmwx	Gyro Compass	lgyr
Knudsen	lknu	P-CODE GPS	tgps
microTSG	utsg	Garmin 17 GPS	lgar
Digital Remote Temperature	lrtm	Seapath 330 GPS	lsep
Fluorometer – Wetlab ECO	ldfl		
ADCP	ladc		
Sound Velocity Probe	lsvp		
GUV & PUV	lguv		
PCO2 System	lpcu		
Oxygen	loxy		
Wet Wall Flows	lsea		
Winches: Dush4,5,&11	lwn1		
Net Depth Sensor	lnds		

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 fields separations are clearly understood. An example 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	
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 Identifier, 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 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	°C
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

Field	Data	Units
33	Digital Input 2	Number
34	Digital Input 3	Number
35	Digital Input 4	Number

### utsg – microTSG, Thermosalinograph

For further information on this data, check [www.seabird.com](http://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

### Irtm – digital Remote Temperature

For further information on this data, check on [www.seabird.com](http://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

### Idfl – 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	

### Igo2 – Oxygen System

For further information on this data, please contact Britt Stephens at [stephens@ucar.edu](mailto: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	jmfclflag - 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	jfl1 - flow in sccm on Inlet Line #1	
17	jfl2 - flow in sccm on Inlet Line #2	
18	jfl1t - 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	jpridge - 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	jtfccl - 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	jt4ch - temperature in C inside USB4CH 24-bit A/D box	
37	jtfcrt - fuel-cell RTD temperature in C	
38	jtirga - temperature in C inside Li7000	
39	jliflags - Li7000 status flag	
40	jlirsrc - 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 [tnewberg@ldeo.columbia.edu](mailto: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	°C
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](mailto: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	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	$\mu\text{W}/\text{cm}^2\text{nm}$
6	Ed0313 - GUV	$\mu\text{W}/\text{cm}^2\text{nm}$
7	Ed0320 - GUV	$\mu\text{W}/\text{cm}^2\text{nm}$
8	Ed0340 - GUV	$\mu\text{W}/\text{cm}^2\text{nm}$
9	Ed0380 - GUV	$\mu\text{W}/\text{cm}^2\text{nm}$
10	Ed0395 - GUV	$\mu\text{W}/\text{cm}^2\text{nm}$
11	Ed0PAR - GUV	$\mu\text{E}/\text{cm}^2\text{sec}$
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	$\mu\text{W}/\text{cm}^2\text{nm}$
6	EdZ313 -PUV	$\mu\text{W}/\text{cm}^2\text{nm}$
7	EdZ320 -PUV	$\mu\text{W}/\text{cm}^2\text{nm}$
8	EdZ395 -PUV	$\mu\text{W}/\text{cm}^2\text{nm}$
9	EdZ340 -PUV	$\mu\text{W}/\text{cm}^2\text{nm}$
10	EdZPAR -PUV	$\mu\text{E}/\text{cm}^2\text{sec}$
11	LuZChl -PUV	$\mu\text{E}/\text{srm}^2\text{sec}$
12	EdZ380 -PUV	$\mu\text{W}/\text{cm}^2\text{nm}$
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	$\mu\text{W}/\text{cm}^2\text{nm}$
21	Ed0313 - GUV	$\mu\text{W}/\text{cm}^2\text{nm}$
22	Ed0320 - GUV	$\mu\text{W}/\text{cm}^2\text{nm}$
23	Ed0340 - GUV	$\mu\text{W}/\text{cm}^2\text{nm}$
24	Ed0380 - GUV	$\mu\text{W}/\text{cm}^2\text{nm}$
25	Ed0395 - GUV	$\mu\text{W}/\text{cm}^2\text{nm}$
26	Ed0PAR - GUV	$\mu\text{E}/\text{cm}^2\text{sec}$
27	Ed0Temp - GUV	°C
28	Ed0VIn	Volts

**Isvp - 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 <sup>1</sup> velocity <sup>2</sup> , East vector	knots
5	Ship Speed relative to reference layer <sup>1</sup> velocity <sup>2</sup> , North vector	knots
6	Ship heading	degrees

<sup>1</sup>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.

<sup>2</sup>The speed output 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+315:23:59:58.194 \$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	

**Isep – 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	

## 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 <sup>1</sup>	
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	

<sup>1</sup>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 \$PGGA,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	\$PGGA 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 <sup>1</sup>	
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	

<sup>1</sup>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	71739	N/A	Collected
Starboard Anemometer	Gill Ultrasonic Wind Observer II	71738	N/A	Collected
Barometer	R.M. Young 61201	BP01150	03-Jun-2011	Collected
Humidity/Wet Temp	RM Young 41372LC	6719	26-Aug-2011	Collected
PAR for Mast	Biosph. Inst. QSR-240P	6393	1-Oct-2012	Collected
PIR	Eppley PIR	32031F3	16-Jul-2012	Collected
PSP	Eppley PSP	31701F3	13-Jul-2012	Collected
GUV (Mast)	Biosph. Inst. GUV-2511	5127	7-Sep-2012	Collected
Transmissometer	WET Labs C-Star 25 cm deep	CST-830DR	04-Nov-2011	Collected
MicroTSG (Primary)	Sea-Bird 45	243	20-Jun-2013	Collected
MicroTSG (Secondary)	Sea-Bird 45	227	21-Jun-2011	Collected
Digital Remote Temp	Sea-Bird 38	324	07-Nov-2012	Collected
Fluorometer	WET Labs ECO-FL	FLRTD-398	07-Sep-11	Collected



## Underway Calibration Sheets

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

### 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

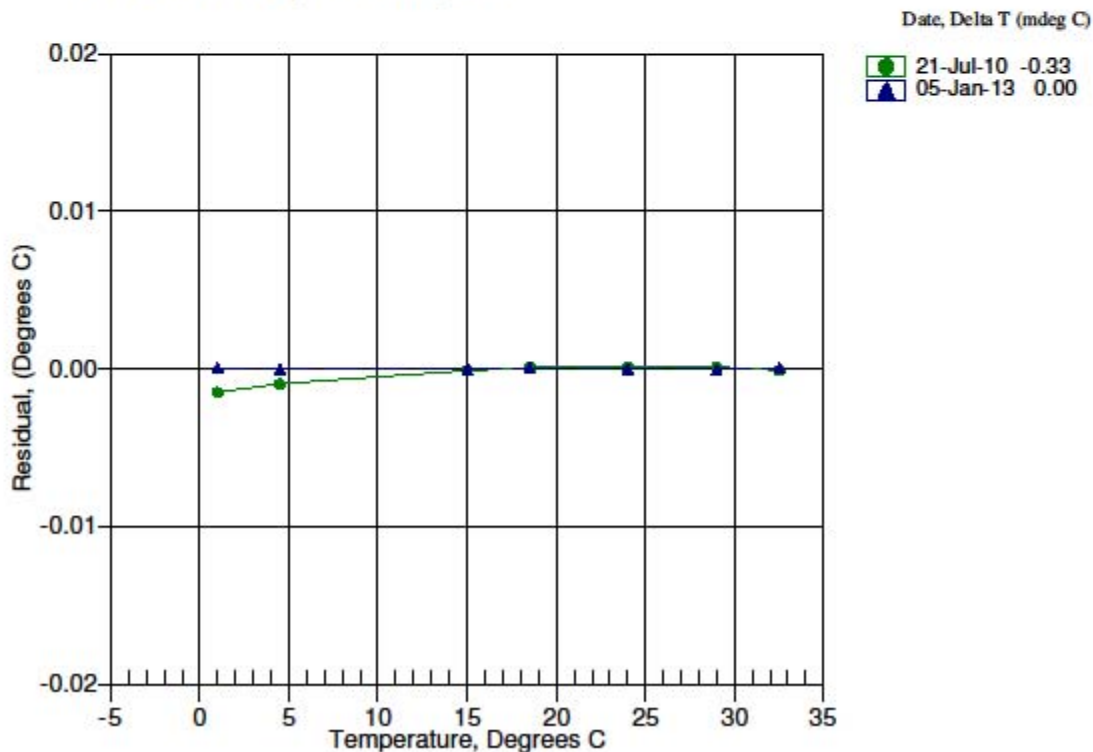
#### ITS-90 COEFFICIENTS

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 =  $1/[a_0 + a_1[\ln(n)] + a_2[\ln^2(n)] + a_3[\ln^3(n)]] - 273.15$  (°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  
h = 1.568761e-001  
i = -2.378281e-004  
j = 4.479479e-005

CPcor = -9.5700e-008  
CTcor = 3.2500e-006  
WBOTC = 1.1173e-006

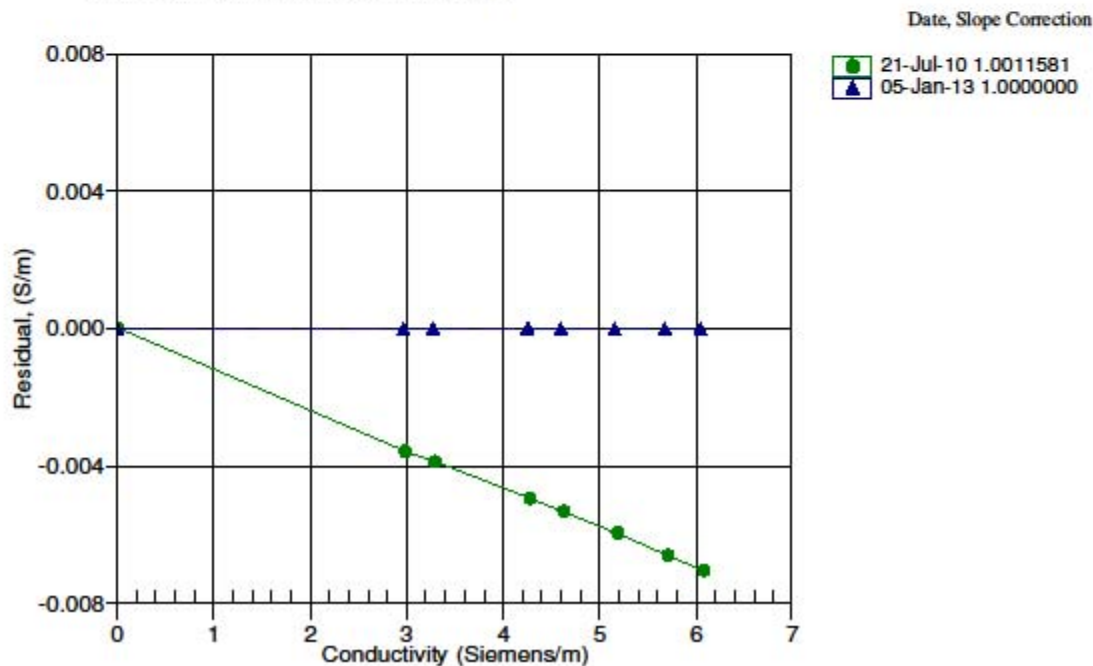
BATH TEMP (ITS-90)	BATH SAL (PSU)	BATH COND (Siemens/m)	INST FREQ (Hz)	INST COND (Siemens/m)	RESIDUAL (Siemens/m)
22.0000	0.0000	0.00000	2535.82	0.00000	0.00000
0.9999	34.7023	2.96714	5034.03	2.96713	-0.00001
4.4999	34.6821	3.27330	5223.68	3.27331	0.00001
14.9999	34.6389	4.25214	5787.67	4.25215	0.00002
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

$$f = \text{INST FREQ} * \sqrt{1.0 + \text{WBOTC} * t} / 1000.0$$

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

t = temperature[°C]; p = pressure[decibars];  $\delta$  = CTcor;  $\epsilon$  = CPcor;

Residual = instrument conductivity - bath conductivity



## Thermosalinograph (Temp) – Secondary

**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: 21-Jun-11SBE-45 TEMPERATURE CALIBRATION DATA  
ITS-90 TEMPERATURE SCALE

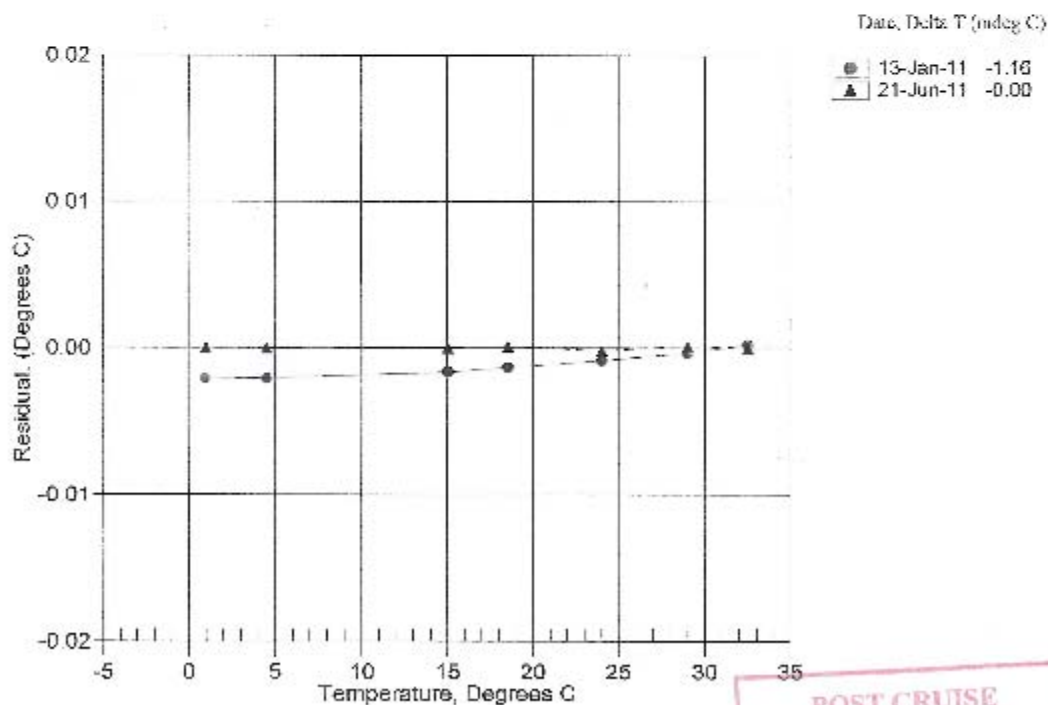
## ITS-90 COEFFICIENTS

$a0 = 4.389651e-005$   
 $a1 = 2.494211e-004$   
 $a2 = 1.946313e-006$   
 $a3 = 1.411505e-007$

BATH TEMP (ITS-90)	INSTRUMENT OUTPUT	INST TEMP (ITS-90)	RESIDUAL (ITS-90)
1.0000	004579.1	1.0000	0.0000
4.0000	008012.5	4.0000	0.0000
15.0000	161626.2	15.0000	-0.0000
19.5000	213024.1	19.5001	0.0001
24.0000	250909.5	23.9998	-0.0002
29.0000	265570.3	29.0001	0.0001
32.5000	280840.5	32.4999	-0.0001

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

Residual = Instrument temperature - bath temperature



**POST CRUISE  
CALIBRATION**

## Thermosalinograph (Conductivity) – Secondary

### SEA-BIRD ELECTRONICS, INC.

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

Phone: (425) 843-9686 Fax (425) 843-9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 0027  
CALIBRATION DATE: 21-Jun-11SBE 45 CONDUCTIVITY CALIBRATION DATA  
PSS 1978, C(35, 5,0) = 4.2914 Siemens/meter

## COEFFICIENTS:

g = -1.0189480e+000

h = 1.4784026e-001

i = -4.340031e-004

j = 6.096783e-006

CPCOR = -9.57000e-008

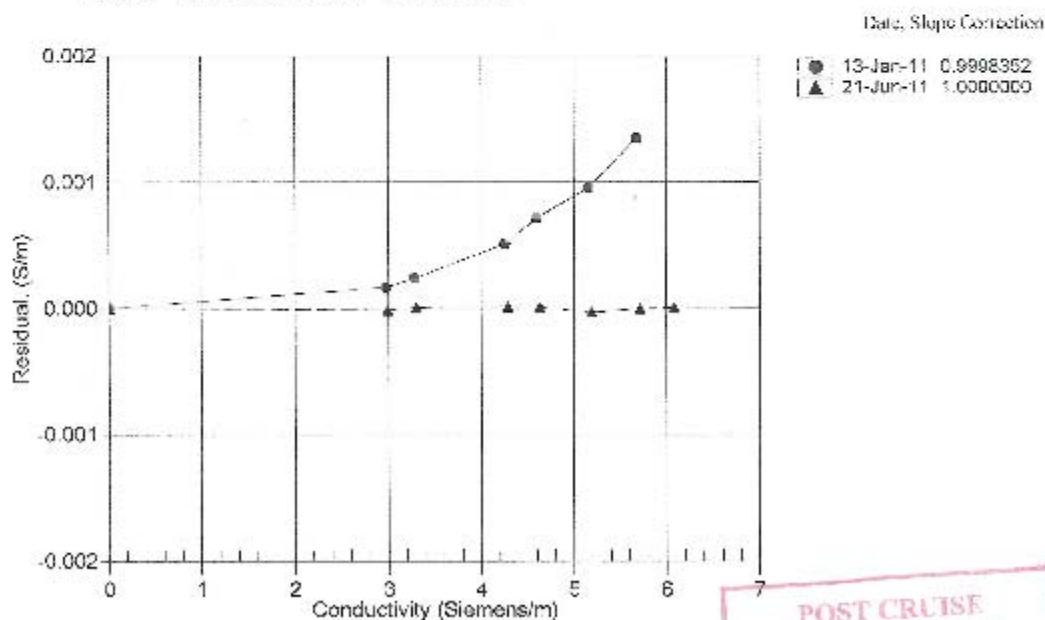
CTCOR = 3.25000e-006

WBOTC = 1.0472e-006

BATH TEMP (ITS-90)	BATH SAL (PSU)	BATH COND (Siemens/m)	INST FREQ (Hz)	INST COND (Siemens/m)	RESIDUAL (Siemens/m)
22.0000	34.0000	0.00000	3546.37	0.00000	0.00000
23.0000	34.9058	2.50753	5010.30	2.98753	0.00001
4.4000	34.9455	3.29571	5238.29	3.29572	0.00001
15.0000	34.9015	4.38096	5803.26	4.38097	0.00002
18.5000	34.8917	4.62729	5888.89	4.62730	0.00001
24.0000	34.0750	5.18703	6276.06	5.18700	0.00003
29.0000	34.8717	5.71037	6534.19	5.71037	-0.00000
32.5000	34.8648	6.08349	6711.84	6.08350	0.00001

 $f = \text{INST FREQ} * \text{sqrt}(1.0 + \text{WBOTC} * t) / 1000.0$ Conductivity =  $(g + hf^2 + if^3 - jf^4) / (1 + 5f - kf)$  Siemens/metert = temperature[°C]; p = pressure[decibars];  $\delta = \text{CTCOR}$ ;  $s = \text{CPCOR}$ 

Residual = instrument conductivity - bath conductivity



## Transmissometer

PO Box 518  
620 Applegate St.  
Philomath, OR 97370



(541) 929-5650  
Fax (541) 929-5277  
[www.wetlabs.com](http://www.wetlabs.com)

## C-Star Calibration

Date	November 4, 2011	S/N#	CST-830DR	Pathlength	25 cm
<b>Analog output</b>					
$V_d$	0.059 V				
$V_{air}$	4.868 V				
$V_{ref}$	4.713 V				
Temperature of calibration water					23.5 °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



(541) 929-5650  
Fax (541) 929-5277  
[www.wetlabs.com](http://www.wetlabs.com)

### ECO Chlorophyll Fluorometer Characterization Sheet

Date: 9/7/2011

S/N: FLRTD-398

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

$$\text{CHL } (\mu\text{g/l}) = \text{Scale Factor} * (\text{Output} - \text{Dark Counts})$$

	Analog Range 1	Analog Range 2	Analog Range 4 (default)	Digital
Dark Counts	0.097	0.053	0.031 V	70 counts
Scale Factor (SF)	6	13	25 µg/lV	0.0076 µg/l/count
Maximum Output	4.96	4.96	4.96 V	16328 counts
Resolution	1.0	1.0	1.0 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:  $SF = x \div (\text{output} - \text{dark counts})$ , 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.xls

Revision J

3/17/08

## Temperature/Relative Humidity

  
YOUNG

### CERTIFICATE OF CALIBRATION AND TESTING

CUSTOMER: RAYTHEON TECHNICAL SERVICES CO LLC  
P.O. NUMBER: RR59937-01  
MODEL: 41372LC  
SERIAL NUMBER: TS06719

R. M. Young Company certifies that the above equipment was inspected and calibrated prior to shipment in accordance with established manufacturing and testing procedures. Standards established by R.M. Young Company for calibrating the measuring and test equipment used in controlling product quality are traceable to the National Institute of Standards and Technology.

To maintain these specifications, regular maintenance intervals are essential.

Date of Certification: 26 August 2011

R.M. Young Company



Ryan Phillips

**R.M. YOUNG COMPANY** 2801 Aero Park Drive, Traverse City Michigan 49686-9171 USA  
TEL: (231) 946-3980 FAX: (231) 946-4772 Email: [rmc@rmyoungusa.com](mailto:rmc@rmyoungusa.com)  
ISO 9001:2008 CERTIFIED

**Barometer**

**R.M. Young Company**  
180 Aero Park Drive  
Troy, Michigan 48066 USA

**CALIBRATION REPORT**  
**Barometric Pressure Sensor**

Customer: *Raytheon Technical Services Company LLC*

Test Number: 1603-01B  
Test Date: 3 June 2011

Customer PO: RR58987-01  
Sales Order: 1959

Test Sensor:	
Model: 61201	Serial Number: BP01150
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	4998	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:  
Druck Pressure Controller Model DPI515  
Fluke Multimeter Model 9080A

Serial # NIST Test Reference  
51500497 UKAS Lab 0221  
4865407 234027

Tested By: *E. Chennery*

METEOROLOGICAL INSTRUMENTS  
Tel: 231-946-3900 Fax: 231-946-4772 Email: [tel.sales@youngusa.com](mailto:tel.sales@youngusa.com) Website: [youngusa.com](http://www.youngusa.com)  
ISO 9001:2008 CERTIFIED



## PIR

**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: 32031F3

Resistance: 709  $\Omega$  at 23°C

Temperature Compensation Range: -20° to +40°C

This pyrometer has been compared against Eppley's Blackbody Calibration System under radiation intensities of approximately 200 watts meter<sup>-2</sup> and an average ambient temperature of 28°C as measured by Standard Omega Temperature Probe, RTD41.

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

$$3.79 \times 10^{-6} \text{ volts/watts meter}^2$$

The calculation of this constant is based on the fact that the relationship between radiation intensity and emf is rectilinear to intensities of 700 watts meter<sup>-2</sup>. This radiometer is linear to within  $\pm 1.0\%$  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: Lockheed Martin (NSF)  
Port Hueneue, CA

Date of Test: July 16, 2012

S.O. Number: 63509  
Date: July 18, 2012

In Charge of Test: *Dale L. Henry*

Reviewed by: *Thomas D. Kirk*

Remarks:

**PSP****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: 31701F3

Resistance: 674  $\Omega$  at 23°C

Temperature Compensation Range: -20° to 140°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<sup>-2</sup> (roughly one half a solar constant).

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

$$8.21 \times 10^{-6} \text{ volts/watts meter}^{-2}$$

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<sup>-2</sup>. This radiometer is linear to within  $\pm 0.5\%$  up to this intensity.

The calibration of this instrument is traceable to standard self-calibrating cavity pyrheliometers in terms of the Systeme 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<sup>-2</sup> min<sup>-1</sup> = 697.3 watts meter<sup>-2</sup>  
 1 BTU/ft<sup>2</sup>-hr<sup>-1</sup> = 3.153 watts meter<sup>-2</sup>

Shipped to: Lockheed Martin (NSF)  
 Port Hueneme, CA

Date of Test: July 13, 2012

S.O. Number: 63509  
 Date: July 18, 2012

In Charge of Test: *Della A. Bivitt*  
 Reviewed by: *Thomas D. Kirk*

Remarks: Replaced Shield

## 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: 0374  
 CALIBRATION DATE: 12-Sep-12

SBE 38 TEMPERATURE CALIBRATION DATA  
 ITS-90 TEMPERATURE SCALE

#### ITS-90 COEFFICIENTS

a0 = -2.504284e-005

a1 = 2.765241e-004

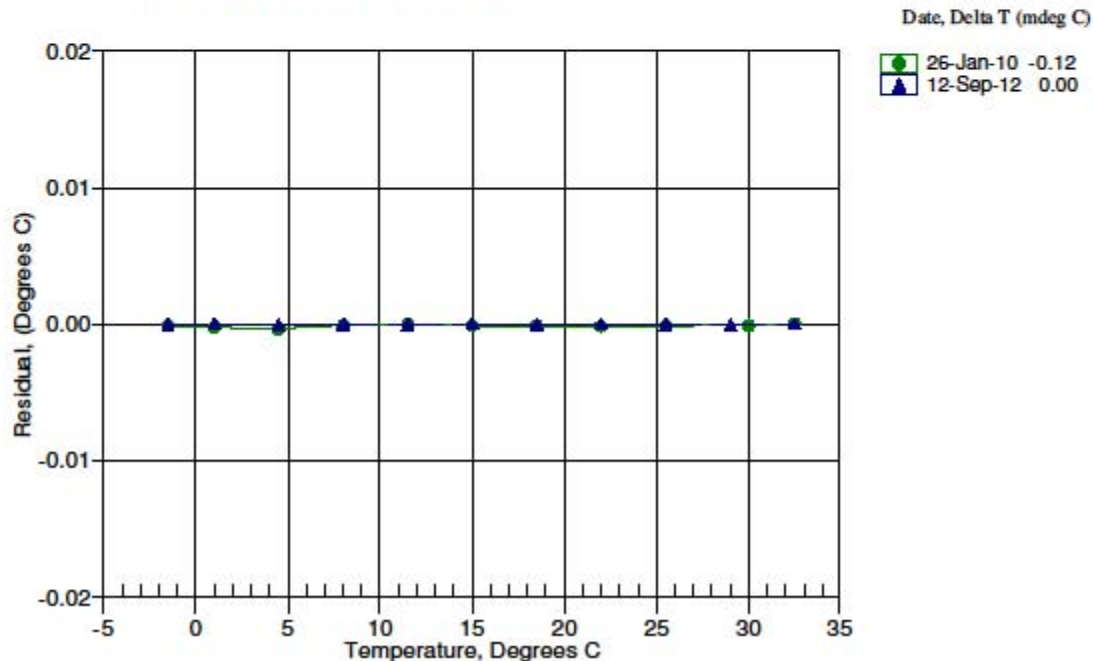
a2 = -2.557210e-006

a3 = 1.541428e-007

BATH TEMP (ITS-90)	INSTRUMENT OUTPUT	INST TEMP (ITS-90)	RESIDUAL (ITS-90)
-1.50000	895410.5	-1.50000	0.00000
0.99990	798438.5	0.99994	0.00004
4.50000	682050.9	4.49991	-0.00009
7.99990	584566.0	7.99992	0.00002
11.50000	502630.7	11.50002	0.00002
15.00000	433537.4	15.00002	0.00002
18.50000	375081.7	18.50001	0.00001
21.99990	325470.0	21.99992	0.00002
25.50000	283231.7	25.49996	-0.00004
29.00000	247165.1	28.99995	-0.00005
32.50000	216277.1	32.50004	0.00004

$$\text{Temperature ITS-90} = 1/[a_0 + a_1[\ln(n)] + a_2[\ln^2(n)] + a_3[\ln^3(n)]] - 273.15 \text{ (}^\circ\text{C)}$$

Residual = instrument temperature - bath temperature



**PAR (mast)****Biospherical Instruments Inc.****CALIBRATION CERTIFICATE**

Calibration Date: 10/1/2012  
 Model Number: QSR-240  
 Serial Number: 3393  
 Operator: TRC  
 Standard Lamp: V-0301277/121  
 Probe Excitation Voltage Range: 0 to 18 VDC(+)

Output Polarity: Positive

Probe Conditions at Calibration (in air):

Calibration Voltage: 6 VDC(+)

Probe Current: 1.3 mA

Probe Output Voltages:

Probe Illuminated: 103.6 mV  
 Probe Dark: 0.4 mV  
 Probe Net Response: 103.2 mV  
 IRG/80: 0.4 mV

Corrected Lamp Output:

Output in Air (same condition as calibration):

9.626E+15 quanta/cm<sup>2</sup>sec  
0.01632 uE/cm<sup>2</sup>sec

Calibration Scale Factor:

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

Dry: 1.0503E-17 V/(quanta/cm<sup>2</sup>sec)  
6.3748E+00 V/(uE/cm<sup>2</sup>sec)

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 maintenance data, when available.

QSR240R 05/24/09

## GUV



## GUV-2511 Calibration Certificate

System Serial Number 25110805127 Date of Calibration 9/7/2012  
 Calibration database 25110805127.v5.mdb Date of Certificate 9/10/2012  
 DASSM 0111 Standard of Spectral Irradiance V-039 (3/7/12)  
 Microprocessor Tag Number 2 Operator TC

Monochromatic Channels	Address	Wavelength [nm]	Responsivity [Amps per $\mu\text{W}(\text{cm}^{-2}\text{nm})$ ]	ScaleSmall [Volts per $\mu\text{W}(\text{cm}^{-2}\text{nm})$ ]	ScaleMedium [Volts per $\mu\text{W}(\text{cm}^{-2}\text{nm})$ ]	ScaleLarge [Volts per $\mu\text{W}(\text{cm}^{-2}\text{nm})$ ]	OffsetSmall [Volts]	OffsetMedium [mVolts]	OffsetLarge [Volts]	Measurement Units
E00305	2	305	$2.3700\text{E}-11$	$4.4922\text{E}-06$	$1.3205\text{E}-03$	$4.0400\text{E}-01$	$4.0400\text{E}-04$	$-4.1771\text{E}-04$	$-6.7771\text{E}-04$	$\mu\text{W}(\text{cm}^{-2}\text{nm})$
E00313	6	313	$1.7300\text{E}-10$	$1.0175\text{E}-05$	$5.3244\text{E}-01$	$7.4008\text{E}-01$	$1.0769\text{E}-04$	$1.7127\text{E}-04$	$6.5976\text{E}-04$	$\mu\text{W}(\text{cm}^{-2}\text{nm})$
E00320	0	320	$2.4164\text{E}-10$	$2.5411\text{E}-06$	$7.4020\text{E}-03$	$2.4930\text{E}-01$	$-1.7100\text{E}-04$	$-1.7066\text{E}-04$	$2.0532\text{E}-05$	$\mu\text{W}(\text{cm}^{-2}\text{nm})$
E00340	-0	340	$1.8761\text{E}-10$	$1.8190\text{E}-05$	$6.6977\text{E}-03$	$2.0977\text{E}-01$	$1.4003\text{E}-04$	$1.3970\text{E}-04$	$1.1687\text{E}-03$	$\mu\text{W}(\text{cm}^{-2}\text{nm})$
E00360	-2	360	$7.0485\text{E}-11$	$7.9465\text{E}-06$	$2.0731\text{E}-03$	$7.2402\text{E}-01$	$-2.3670\text{E}-04$	$-2.4710\text{E}-04$	$-7.0793\text{E}-04$	$\mu\text{W}(\text{cm}^{-2}\text{nm})$
E00395	-3	395	$2.8722\text{E}-10$	$2.8433\text{E}-06$	$8.8007\text{E}-03$	$2.6279\text{E}-01$	$-1.7243\text{E}-03$	$-7.7336\text{E}-04$	$-3.9703\text{E}-04$	$\mu\text{W}(\text{cm}^{-2}\text{nm})$
Brandband Channels	Address	Wavelength [nm]	Responsivity [Amps per $\mu\text{E}(\text{cm}^{-2}\text{nm})$ ]	ScaleSmall [Volts per $\mu\text{E}(\text{cm}^{-2}\text{nm})$ ]	ScaleMedium [Volts per $\mu\text{E}(\text{cm}^{-2}\text{nm})$ ]	ScaleLarge [Volts per $\mu\text{E}(\text{cm}^{-2}\text{nm})$ ]	OffsetSmall [Volts]	OffsetMedium [mVolts]	OffsetLarge [Volts]	Measurement Units
E00PAR	15	400-700	$1.6536\text{E}-05$	$1.6520\text{E}-01$	$4.9607\text{E}-02$	$1.6533\text{E}-05$	$-8.3676\text{E}-05$	$-3.2969\text{E}-05$	$5.2459\text{E}-04$	$\mu\text{E}(\text{cm}^{-2}\text{nm})$
Auxiliary Channels	Address	Wavelength [nm]	Responsivity	ScaleS	ScaleM	ScaleL	OffsetS	OffsetM	OffsetL	Measurement Units
E00Temp	22	0	1	$3.0^{\circ}$	$3.0^{\circ}$	$0.01$	0	0	0	$^{\circ}\text{C}$
E00Yln	27	0	1	0.25	0.25	-0.25	0	0	0	V

\* Biospherical Instruments Inc., 5340 Riley Street, San Diego, California 92110 USA. Contact [support@biospherical.com](mailto:support@biospherical.com) for more information.

Calibration Data Do Not Destroy

Page 2 of 2

## 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

### 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
044	04:31 hrs	Data logging is ON	@68° West
045	00:22	Bottom Track Off ADCP	Going off the shelf
045	20:42	Air Sample	59°S
047	10:55	Data logging/ADCP OFF	At Palmer
050	21:25	Replaced O2 trap	@ Palmer
052	12:07	Underway mode	Leaving Palmer
054	n/a	Swapped O2 trap	Underway, weekly, Saturday
059	16:05	Air Sample	59°S
060	~13:00	ADCP Bottom Tracking ON	<500m
061	~16:00	Swapped O2 trap	Underway, weekly, Saturday
062	12:16	In port Mode	68W