

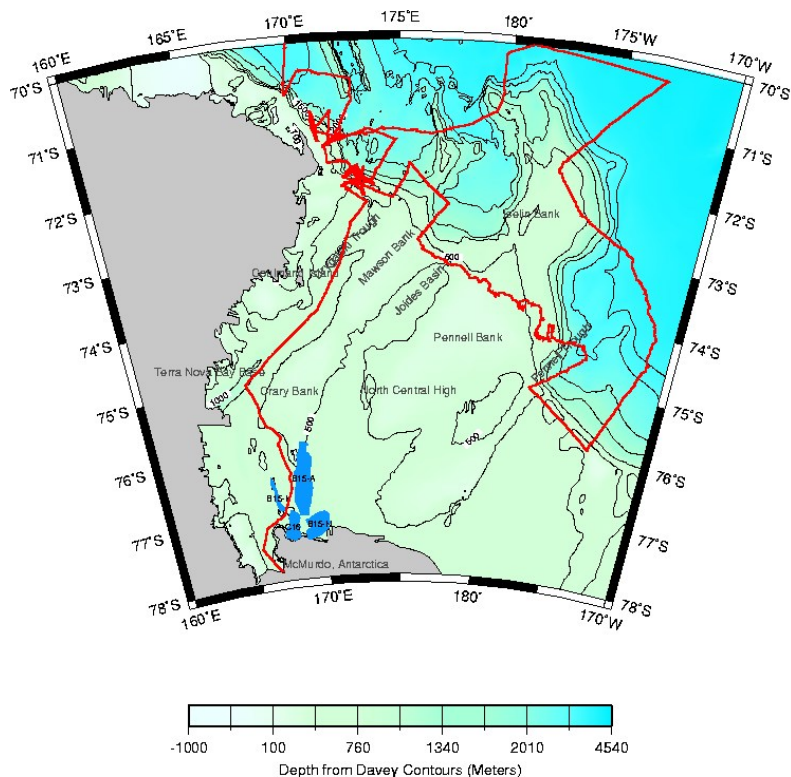
Data Report

NBP0402

Anslope II

February 23 – April 10, 2004

NBP0402 - AnSlope II



GMT 2004 Apr 5 05:29:22 S.O'Hara,RPSC

United States Antarctic Program

RVIB Nathaniel B. Palmer

Raytheon Polar Services

Data Report Prepared by:
Paul Huckins and Kevin Bliss

Table of Contents

INTRODUCTION.....	1
DISTRIBUTION CONTENTS AT A GLANCE	2
EXTRACTING DATA.....	2
DISTRIBUTION CONTENTS	3
CRUISE INFORMATION.....	3
<i>Cruise Track</i>	3
<i>Satellite Images</i>	3
<i>Science Report</i>	3
<i>Other</i>	3
NBP DATA PRODUCTS	3
<i>JGOFS</i>	3
<i>MGD77</i>	4
SCIENCE OF OPPORTUNITY	5
<i>ADCP</i>	5
<i>pCO₂</i>	6
CRUISE SCIENCE	6
<i>CTD</i>	6
<i>XBT</i>	7
RVDAS	7
SENSORS AND INSTRUMENTS	7
Underway Sensors	8
Meteorology and Radiometry.....	8
Geophysics	8
Oceanography.....	8
Navigational Instruments	8
<i>Data</i>	9
Underway Data	9
Sound Velocity Probe (svp1).....	9
Meteorology (met1).....	9
Gravimeter (grv1).....	10
Bathy 2000 (bat1).....	10
Simrad EM120 (mbdp).....	11
Simrad EK500 (sim1).....	11
Thermosalinograph (tsg1)	12
Fluorometer (flr1).....	12
Navigational Data.....	13
Seapath GPS (seap)	13
Ashtech GPS (ada)	15
Trimble (P-Code) GPS (PCOD)	16
Gyro Compass (gyr1)	17
ADCP Course (adcp).....	17
PROCESS	18
pCO ₂ -merged	18
tsgfl.....	18
CALCULATIONS.....	19
TSG	19
PAR.....	19
PIR.....	19
PSP	20
ACQUISITION PROBLEMS AND EVENTS.....	21

APPENDIX: SENSORS AND CALIBRATIONS.....	23
NBP0402 SHIPBOARD SENSORS.....	23
<i>NBP0402 CTD Sensors:</i>	24
<i>Anemometer (Port)</i>	25
<i>Anemometer (Starboard)</i>	26
<i>Temperature Sensor</i>	27
<i>PIR</i>	28
<i>PSP</i>	29
<i>PAR</i>	30
TSG CALIBRATION FILES	31
<i>Underway Conductivity Sensor</i>	31
<i>Underway Temperature Sensor</i>	32
<i>Underway Remote Temperature Sensor</i>	33
<i>Underway Transmissometer #1</i>	34
<i>Underway Transmissometer #2</i>	35
<i>Underway Transmissometer #3</i>	35
<i>Underway Transmissometer #3</i>	36
<i>Gravity Tie Meter</i>	37
<i>CTD Fish/Pressure sensor</i>	38
<i>CTD Temperature (Primary)</i>	39
<i>CTD Temperature (Secondary)</i>	40
<i>Conductivity (Primary)</i>	41
<i>Conductivity (Secondary)</i>	42
<i>CTD Dissolved Oxygen</i>	43
<i>CTD Transmissometer</i>	44
<i>CTD Fluorometer</i>	45
<i>CTD PAR</i>	46

Introduction

The NBP data acquisition systems continuously log data from the instruments used during the cruise. This document describes:

- The structure and organization of the data on the distribution media
- The format and contents of the data strings
- Formulas for calculating values
- Information about the specific instruments in use during the cruise
- A log of acquisition problems and events during the cruise that may affect the data
- Scanned calibration sheets for the instruments in use during the cruise.

The data is distributed on DVD-R or CD-ROM media, written in ISO9660 level-1 format. It is readable by virtually every computing platform.

All the data has been compressed using Unix "gzip," identifiable by the ".gz" extension. It has been copied to the distribution media in the Unix tar archive format, ".tar" extension. Tools are available on all platforms for uncompressing and de-archiving these formats: On Macintosh, use Stuffit Expander with DropStuff. On Windows operating systems use WinZip.

MultiBeam and BathyW data, if collected, are distributed separately.

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

Distribution Contents at a Glance

Volume (DVD) 1

/ 0402data.doc
instcoef.txt
NBP0402.trk
NBP0402.gmt
NBP401b.gmt.

rvdas/uw/ 0402bat.tar
0402flr.tar
0402grv.tar
0402met.tar
0402pco2.tar
0402sim.tar
0402svp.tar
0402tsg.tar
0402mbdp.tar

rvdas/nav/0402adu.tar
0402adcp.tar
0402gyr.tar
0402seap.tar
0402PCOD.tar

Volume (DVD) 1

adcp/ pingdata files
config files
sci_rep.pdf

imagery/ images.tar

ocean/xbt 0402xbt.tar

ocean/ctd 0402proc.tar
0402raw.tar

process/ 0402jgof.tar
0402mgd.tar
0402proc.tar
0402pco2.tar
0402qcps.tar
0402trk

sci_rep/ weeklies.tar
sci_rep.pdf
sci_rep.pdf

Extracting Data

The Unix tar command has many options. It is often useful to know exactly how an archive was produced when expanding its contents. All archives were created using the command,

```
tar cvf archive_filename files_to_archive
```

To create a list of the files in the archive, use the Unix command,

```
tar tvf archive_filename > contents.list
```

where `contents.list` is the name of the file to create

To extract the files from the archive:

```
tar xvf archive_filename file(s)_to_extract
```

G-zipped files will have a “.gz” extension on the filename. These files can be decompressed after de-archiving, using the Unix command,

```
gunzip filename.gz
```

Distribution Contents

Cruise Information

NBP0402 was a Physical Oceanography cruise that started out of McMurdo Station on February 23, 2004 and concluded in Lyttleton New Zealand on April 10, 2004. We collected standard underway and navigational data, Multi-Beam, CTD and LADCP.

Multi-Beam data was collected through the 200 mile EEZ zone limit of New Zealand. There were four copies of Multi-Beam data distributed. The standard two, one for RPSC-HQ and one for the NBP, plus two to the science party on DLT tape.

Cruise Track

The distribution DVD includes a GMT cruise track file (NBP0402.trk). It contains the longitude and latitude at one-minute intervals extracted from the NBP0402.gmt file. There is a second GMT track file in the big Indian format called NBP402b.gmt.

Two PostScript cruise track files have been produced and placed in the root directory. NBP0402.ps is poster-sized (~36" x 40") and 402_smal.ps is standard US Letter sized (8.5" x 11").

Satellite Images

Satellite Images processed for this cruise can be found in the directory, /Imagery in two subdirectories, ice and wx (weather). Files are named using the convention, IdDDDDYYA.jpg where:

Id = image type (is = ice ssmi, iv = ice visible, cw = seawifs, wx = weather)

DDD = year-day

YY = year

A = allows for multiple images of one type for one day

Science Report

The weekly science reports and final cruise science report are in the /sci_rep directory.

Other

There is a directory on the DVD called other. It contains various cruise related files that are not described in detail in this document. It has things like mooring drawings, and brief descriptions of other cruise projects.

NBP Data Products

Two processed datasets are created on each NBP cruise: JGOFS and MGD77.

JGOFS

The JGOFS data set can be found on the distribution media in the file /process/<cruiseino>.tar. The archive contains a single file produced each day named jgDDD.dat.gz where DDD is the year-day the data was acquired. The ".gz" extension indicates that the individual files are compressed before archiving. The daily file consists of 22 columnar fields in text format described in the table below. The JGOFS data set is obtained primarily by applying calibrations to raw data and decimating to whole minute intervals. Several fields are derived measurements from more than a single raw input. For example, Course Made Good (CMG) and Speed Over Ground (SOG) are calculated from gyro and GPS inputs. During the cruise, the JGOFS data set produces the daily data plots. Note: Null, unused, or unknown fields are indicated as "NAN" as 9999 in the JGOFS data.

Field	Data	Units
01	GMT date	dd/mm/yy
02	GMT time	hh:mm:ss
03	NGL latitude (negative is South)	tt.tttt
04	NGL longitude (negative is West)	ggg.gggg
05	Speed over ground	Knots
06	GPS HDOP	-
07	Gyro Heading	Degrees (azimuth)
08	Course made good	Degrees (azimuth)
09	Mast PAR	μ Einsteins/meter ² sec
10	Sea surface temperature	°C
11	Sea surface conductivity	siemens/meter
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	volts (0-5 FSO)
20	Not used	-
21	PSP	W/m ²
22	PIR	W/m ²

MGD77

The MGD77 data set is contained in a single file for the entire cruise. It can be found in the top level of the distribution data structure as 0402mgd. Also at the root level, 0402gmt is the output of the mgd77togmt utility using 0402mgd as input. The 0402gmt file can be used by GMT plotting software.

The data used to produce the 0402mgd file can be found on the distribution media in the file /process/0402proc.tar. The data files in the archive contain a day's data and follow the naming convention Dddd.fnl.gz, where ddd is the year-day. These files follow a space-delimited columnar format that may be more accessible for some purposes. They contain data at one-second intervals rather than one minute and are individually "gzipped" to save space. Below is a detailed description of the MGD77 data set format. The other files in the archive contain interim processing files and are included to simplify possible reprocessing of the data using the RVDAS NBP processing scripts.

All decimal points are implied. Leading zeros and blanks are equivalent. Unknown or unused fields are filled with 9's. All "corrections", such as time zone, diurnal magnetics, and EOTVOS, are understood to be added.

Col	Len	Type	Contents	Description, Possible Values, Notes
1	1	Int	Data record type	Set to "5" for data record
2-9	8	Char	Survey identifier	
10-12	3	int	Time zone correction	Corrects time (in characters 13-27) to GMT when added; 0 = GMT
13-16	4	int	Year	4 digit year
17-18	2	int	Month	2 digit month
19-20	2	int	Day	2 digit day
21-22	2	int	Hour	2 digit hour
23-27	5	real	Minutes x 1000	
28-35	8	real	Latitude x 100000	+ = North - = South. (-9000000 to 9000000)
36-44	9	real	Longitude x 100000	+ = East - = West. (-18000000 to 18000000)

Col	Len	Type	Contents	Description, Possible Values, Notes
45	1	int	Position type code	1=Observed fix 3=Interpolated 9=Unspecified
46-51	6	real	Bathymetry, 2- way travel time	In 10,000th of seconds. Corrected for transducer depth and other such corrections
52-57	6	real	Bathymetry, corrected depth	In tenths of meters.
58-59	2	int	Bathymetric correction code	This code details the procedure used for determining the sound velocity correction to depth
60	1	int	Bathymetric type code	1 = Observed 3 = Interpolated (Header Seq. 12) 9 = Unspecified
61-66	6	real	Magnetics total field, 1 ST sensor	In tenths of nanoteslas (gammas)
67-72	6	real	Magnetics total field, 2 ND sensor	In tenths of nanoteslas (gammas), for trailing sensor
73-78	6	real	Magnetics residual field	In tenths of nanoteslas (gammas). The reference field used is in Header Seq. 13
79	1	int	Sensor for residual field	1 = 1 st or leading sensor 2 = 2 nd or trailing sensor 9 = Unspecified
80-84	5	real	Magnetics diurnal correction	In tenths of nanoteslas (gammas). (In nanoteslas) if 9-filled (i.e., set to "+9999"), total and residual fields are assumed to be uncorrected; if used, total and residuals are assumed to have been already corrected.
85-90	6	F6.0	Depth or altitude of magnetics sensor	(In meters) + = Below sea level 3 = Above sea level
91-97	7	real	Observed gravity	In 10 th of mgals. Corrected for Eotvos, drift, tares
98-103	6	real	EOTVOS correction	In 10 th of mgals. $E = 7.5 V \cos \phi \sin \alpha + 0.0042 V^2$
104-108	5	real	Free-air anomaly	In 10 th of mgals G = observed G = theoretical
109-113	5	char	Seismic line number	Cross-reference for seismic data
114-119	6	char	Seismic shot-point number	
120	1	int	Quality code for navigation	5=Suspected, by the originating institution 6=Suspected, by the data center 9=No identifiable problem found

Science of Opportunity

ADCP

The shipboard ADCP system measures currents in the depth range from about 30 to 300 m -- in good weather. In bad weather or in ice, the range is less, and sometimes no valid measurements are made. It is the USAP-funded project of Eric Firing (University of Hawaii) and Teri Chereskin (Scripps Institution of Oceanography). ADCP data collection occurs on the both LMG and the NBP for the benefit of the scientists on individual cruises, and for the long-term goal of building a climatology of current structure in the Southern Ocean.

The ADCP data set collected during this cruise has been placed on the distribution media in the archive /adcp/0402adcp.tar. The archive consists of a single file for each day of data collection. The files are named PINGDATA.xxx where xxx is a day number that is NOT a year-day. For the date, use the file's creation date.

Some ADCP data is also transmitted to RVDAS. East and north vectors for ship's speed relative to the reference layer and ship's heading are archived as 0402adcp.tar in the directory /rvdas/nav.

At the request of the science party we have also included the raw ADCP data in the file /adcp/0402raw.tar and a processed ADCP data set called sndspd.tar.

pCO₂

The NBP carries Lamont-Doherty Earth Observatory's (LDEO) pCO₂ system and RPSC staff maintain it. Data is sent to LDEO at the end of each cruise. The pCO₂ data is transmitted and archived on RVDAS. You will find it in a file named 0402pco2.tar in the /process directory, which contains the pCO₂ instrument's data merged with GPS, meteorological and other oceanographic measurements. For more information contact Colm Sweeney (csweeney@ldeo.columbia.edu).

Cruise Science

CTD

The ctd data and report have been placed in the tar file 0402ctd.tar, which contains the flowing structure:

ctd.list (list of all ctd stations)	report/section/ (section plots)
ctdsetup/ (batch files, cfg & con files)	casts/ (plots of individual casts)
data/ (raw datafiles)	text/ (ctd data report)
plots/ (up & down trace postscript plots)	seacat/ (data structure for SeaCat ctd)
seasoft4.234/ (application for processing ctd data)	

Individual CTD casts are represented by a set of four files containing a bottle-firing file (.bl), a configuration file (.con), a data file (.dat) and a header file (.hdr). Casts are numbered according to the cruise id number (0402) followed by the number of the cast. For example; the raw files associated with the third cast on this cruise are: 0402003.bl, 0104003.con, 0402003.dat, 0402003.hdr. The raw and processed data files are in binary format. The 1 db bin averaged up and down traces have been converted to ascii (.asc files).

SeaBird's SeaSoft software used to acquire the data is included in the CTD data distribution in the "Seasoft" directory. SeaSoft is a DOS-based software package, but can be run in a DOS window under the Windows9X operating systems for cast playback and data analysis. The software package used to process this data (version 4.234) is included on this CD in the directory **Seasoft**. The configuration files and processing scripts (written by Suzanne O'Hara for the standard processing of the SBE 9/11*plus*) are also included in the **Seasoft** directory under in the **ctdsetup** directory. The directory **report** contains the CTD data report with folder for all plots produced during the cruise. The directory **seacat** has a structure similar to the ctd directory and contains the data from the SeaCat CTD unit.

File extension definitions:

EXT	Description
ASC	The data portion of a .CNV converted data file written in ASCII by ASCIIOUT, or files written by TERM37.
BL	Created by SEASAVE when a bottle fire confirmation is received. Contains bottle sequence number, position, date, time, beginning and ending scan numbers.
BTL	Created by ROSSUM. This is a summary of the data in a .ROS file.

BSR	Bottle scan range file, used by DATCNV to create a .ROS file.
CFG	Used by SEASOFT modules to store the input filename, input data path, output data path, and other miscellaneous module specific parameters.
CTR	Density contour file generated by CONTOUR.
CNV	'Converted' engineering unit data file. An ASCII header precedes the data.
CON	Contains instrument configuration and calibration coefficients, used by SEACON, SEASAVE, and DATCNV
DAT	Raw binary data, optionally with header information (SBE 9/11, 11X, 9/11 <i>plus</i> , and data files created with previous versions of SEASOFT).
DSP	Used by SEASAVE to store data acquisition and display parameters.
HDR	1) Header portion of a .CNV converted data file written by ASCIIOUT. 2) Header recorded when acquiring real time data or uploading archived data.
HEX	Raw HEX data with header information (SBE 16, 17, 19, 21, and 25)
MRK	Marker file created by SEASAVE during real time data acquisition.
PLT	Used by SEAPLOT to store display parameters
ROS	Scans marked with the bottle fire confirmation bit, or defined by a .BSR file, written by DATCNV.

*Note: This is a complete list of all file extensions. This data set may not contain ALL of the above extension files.

SEASOFT modules search the current directory for DSP, PLT, and CFG files. SEASOFT modules search the 'input data path' for CON, HEX, DAT, and CNV files. One exception is SEACON which searches the current directory for CON files.

For more information and updated software visit the web site at www.seabird.com; or contact (206) 643-9866, seabird@seabird.com, Sea-Bird Electronics 1808 – 136th Place NE Bellevue, WA 98005

XBT

During the cruise Expendable Bathythermographs were used to obtain water column temperature profiles. These were used to adjust the sound velocity profile for the multibeam system. The data files from these launches are included as 0402xbt.tar in the /ocean directory.

RVDAS

The Research Vessel Data Acquisition System (RVDAS) was developed at Lamont-Doherty Earth Observatory of Columbia University and has been in use on its research ship for many years. It has been extensively adapted for use on the USAP research vessels.

Daily data processing of the RVDAS (Research Vessel Data Acquisition System) data is performed to convert values into useable units and as a check of the proper operation of the DAS. Both raw and processed data sets from RVDAS are included in the data distribution. The tables below provide detailed information on the data. Be sure to read the "Significant Acquisition Events" section for important information about data acquisition during this cruise.

Sensors and Instruments

RVDAS data is divided into two general categories, *underway and navigation*. They can be found on the distribution media as subdirectories under the top level rvdas directory: /rvdas/uw, and /rvdas/nav. Processed oceanographic data is in the top level directory, /process. Each instrument or sensor produces a data file named with its channel ID. Each data file is g-zipped to save space on the distribution media. Not all data types are collected every day or on every cruise.

The naming convention for data files produced by the sensors and instruments is

NBP[CruiseID][ChannelID].dDDD

Example: NBP0107.met1.d317

- The CruiseID is the numeric name of the cruise, in this case, 0402

- The ChannelID is a 4-character code representing the system being logged. An example is "met1," the designation for meteorology.
- DDD is the day of year the data was collected

Underway Sensors

Meteorology and Radiometry

Measurement	Channel ID	Collect. Status	Rate	Instrument
Air Temperature	met1	Continuous	1 sec	R. M. Young 41372LC
Relative Humidity	met1	Continuous	1 sec	
Wind Speed/Direction	met1	Continuous	1 sec	R.M. Young 05106
Barometer	met1	Continuous	1 sec	R.M. Young 61201
PIR (LW radiation)	met1	Continuous	1 sec	Eppler PIR
PSP (SW radiation)	met1	continuous	1 sec	Eppler PSP
PAR	met1	continuous	1 sec	BSI QSR-240
GUV	guv	collected	2 sec	BSI PUV-511
PUV	puv	not collected		BSI PUV-500

Geophysics

Measurement	Channel ID	Collect. Status	Rate	Instrument
Gravimeter	grv1	Continuous	10 sec*	LaCoste & Romberg
Magnetometer	mag1	Continuous	15 sec	EG&G G-877
Bathymetry	bat1	Continuous	Varies	ODEC Bathy 2000
Bathymetry	knu1	Not collected	Varies	Knudsen 320B/R
Bathymetry	sim1	Depth < 2500 m	Varies	Simrad EK500 Sonar

*Data is output every second but it only changes every 10 seconds.

Oceanography

Measurement	Channel ID	Collect. Status	Rate	Instrument
Conductivity	tsg1	Continuous	6 sec	SeaBird 21
Salinity	tsgfl	Continuous	6 sec	Calc. from pri. temp
Sea Surface Temp	tsg1	Continuous	6 sec	SeaBird 3-01/S
Fluorometry	flr1	Continuous	1 sec	Turner 10-AU-005
Fluorometry	flr1 & tsg1	Continuous	6 sec	
Transmissometry	tsg1	Continuous	6 sec	WET Lab C-Star
pCO ₂	pco2	Continuous	70 sec	(LDEO)
ADCP	adcp	Continuous	varies	RD Instruments

Navigational Instruments

Measurement	Channel ID	Collect. Status	Rate	Instrument
Attitude GPS	Adu1	continuous	1 sec	Ashtech ADU2
Trimble GPS	PCOD	Continuous	1 sec	Trimble 20636-00SM
Gyro	gyr1	Continuous	0.2 sec	Yokogawa Gyro

Measurement	Channel ID	Collect. Status	Rate	Instrument
SeaPath	Seap	Continuous	1 sec	SeaPath 200

Data

Data is received from the RVDAS system via RS-232 serial connections. A time tag is added at the beginning of each line of data in the form,

```
yy+dd:hh:mm:ss.sss [data stream from instrument]
```

where

yy = two-digit year

ddd = day of year

hh = 2 digit hour of the day

mm = 2 digit minute

ss.sss = seconds

All times are reported in UTC.

The delimiters that separate fields in the raw data files are often spaces and commas but can be other characters such as : = @. Occasionally no delimiter is present. Care should be taken when reprocessing the data that the field's separations are clearly understood.

In the sections below a sample data string is shown, followed by a table that lists the data contained in the string.

Underway Data

Sound Velocity Probe (svp1)

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

Field	Data	Units
1	RVDAS Time tag	
2	Sound velocity in ADCP sonar well	m/s

Meteorology (met1)

```
01+322:00:03:27.306 04.5 292 010 05.7 294 010 0959.6 000.2 093 -000.1537
0001.0886 0012.8248
```

Field	Data	Units
1	RVDAS time tag	
2	Port anemometer speed (relative)	m/s
3	Port anemometer direction (relative)	deg
4	Port anemometer standard deviation	deg
5	Starboard anemometer speed (relative)	m/s
6	Starboard anemometer direction (relative)	deg
7	Starboard anemometer standard deviation	deg
8	Barometer	mBar
9	Air temperature	°C
10	Relative humidity	%
11	PSP (short wave radiation)*	mV

Field	Data	Units
12	PIR (long wave radiation)*	mV
13	PAR (photosynthetically available radiation)*	mV

*See page 19 for calculations.

Gravimeter (grv1)

99+099:00:18:19.775 your_line#1999 99 01818 9735.4

Field	Data	Conversion	Units
1	RVDAS time tag		
2	Text string		
3	Gravity device date	yyyymmddhhmmss	
4	Gravity count	mgal = count x 1.0046 + offset	count

Bathy 2000 (bat1)

00+019:23:59:53.901 ;I04485.3ME -23.0, I00000.0,-99.9,00000@01/11/00, 23:59:52.08

PW2 PF1 SF1 PL3 MO4 SB3 PO0 TX1 TR: GM5 1500 06.7 -72.1

Field	Data	Format / Possible Values	Units
1	RVDAS time tag		
2	Flagged low frequency chn. depth w/ units	;FDDDDD.Dun where F = flag (V for valid, I for invalid), D=depth, un = units	meters
3	Low Frequency echo strength	EEE.EE	dB
4	Flagged high freq. chn. depth	not used	
5	High frequency echo strength	not used	
6	Signed heave data	SHHHH	cm
7	Date	mm/dd/yy	
8	Time	hh:mm:ss	
9	Transmit pulse window type	PW1=Rectangular PW2=Hamming PW3=Cosine PW4=Blackman	
10	Primary transmit frequency	PF1=3.5 kHz PF2=12.0 kHz	kHz
11	Parametric mode secondary frequency	SF1=3.5 kHz SF2=12.0 kHz	kHz
12	Pulse length	PL1=200usec PL2=500usec PL3=1msec PL4=2msec PL5=5msec PL6=10msec PL7=25msec If transmit mode is FM: PL1=25msec PL2=50msec PL3=100msec	
13	Operating mode	MO1=CW parametric MO2=CW MO3=FM parametric MO4=FM	

Field	Data	Format / Possible Values	Units
14	Frequency sweep bandwidth	SB1=1 kHz SB2=2 kHz SB3=5 kHz	kHz
15	Power level	PO1 = 0dB PO2 = -6dB PO3 = -12dB PO4 = -18dB PO5 = -24dB PO6 = -30dB PO6 = -30 dB PO7 = -36dB PO8 = -42dB	
16	Transmit mode	TX1=single ping active TX2=pinger listen TX3=multipinging TR TX4=multipinging TR TX5=multipinging TTRR TX6=multipinging TTTTRRRR TX7=multipinging TTTTTRRRRR	
17	Transmit Rate	TR3 = 4Hz TR4 = 2Hz TR5 = 1Hz TR6 = .5Hz TR7 = .33Hz TR8 = .25Hz TR9 = .20Hz TR: = .10Hz TR; = .05Hz	Hz
18	System gain mode	GM0=hydrographic AGC GM1 to GM9=hydrographic +3db to + 27db manual. GMA to GMD=hydrographic + 30db through + 60db manual GME to GMK=sub-bottom 1 through sub-bottom 7	
19	Speed of sound		m/sec
20	Depth of sonar window below sea-level		meters
21	Background noise level in fixed point reference		dB/V

Simrad EM120 (mbdp)

Field	Data	Units
1	LDTDS	
2	\$EMDPT	
3	Depth (corrected)	Meters

Simrad EK500 (sim1)

00+005:00:00:52.388 D1,23583509,1479.6, 17, 1, 0

On this cruise the EK500 was also set to collect backscatter data. See data distribution /rvdas/uw/ek500.cfg for the exact configuration(backscatter data not described in this document)

Field	Data	Units
1	RVDAS time tag	
2	Header	
3	Time tag	hhmmss.sss
4	Depth	m
5	Bottom surface backscattering strength	dBar
6	Transducer number (1 = 38 kHz)	
7		

Thermosalinograph (tsg1)

00+019:23:59:46.976 15A16CFC163F8C2C100

Field	Data	Units
1	RVDAS time tag	
2	Seabird hex string (see page 19 for conversion to real units)	

Fluorometer (flr1)

00+019:23:59:58.061 0 0818 :: 1/19/00 17:23:17 = 0.983 (RAW) 1.2 (C)

Field	Data	Units
1	RVDAS time tag	
2	Marker 0 to 8	
3	4-digit index	
4	Date	mm/dd/yy
5	Time	hh:mm:ss
6	Signal	
7	signal units of measurement	
8	cell temperature	
9	Temperature units	

pCO₂

04+020:07:28:02.038 2004021.31097 2399.36 31.97 986.1 251.93
 -0.28 243.7 50.96 0 13 Equil

(Note: Both tabs and spaces are included in this string.)

Field	Data	Units
1	RVDAS time tag	
2	pCO ₂ time tag (decimal is fractional time of day)	yyyymmdd.tttt
3	Raw Voltage	mV
4	Cell Temperature	°C
5	Barometer	mBar
6	CO ₂ concentration	ppm
7	Equilibrator Temp.	°C
8	pCO ₂	µAtmos
9	Flow Rate	cc/min
10	Sample code	
11	Valve position code	
12	Sample ID ("Equil", "Atmos", etc.)	

Navigational Data

Seapath GPS (seap)

The Seapath GPS outputs six data strings, four in NMEA format and two in proprietary PSXN format:

- GPZDA
- GPGGA
- GPVTG
- GPHDT
- PSXN, 22
- PSXN, 23

GPZDA

02+253:00:00:00.772 \$GPZDA,235947.70,09,09,2002,,*7F

Field	Data	Units
1	RVDAS time tag	
2	\$GPZDA	
3	time	hhmmss.ss
4	Day	dd
5	Month	mm
6	Year	yyyy
7	(empty field)	
8	Checksum	

GPGGA

02+253:00:00:00.938

GPGGA,235947.70,6629.239059,S,06827.668899,W,1,07,1.0,11.81,M,,M,,*6F

Field	Data	Units
1	RVDAS time tag	
2	\$GPGGA	
3	time	hhmmss.ss
4	Latitude	ddmm.mmmmmm
5	N or S for north or south latitude	
6	Longitude	ddmm.mmmmmm
7	E or W for east or west longitude	
8	GPS quality indicator, 0=invalid, 1=GPS SPS, 2=DGPS, 3=PPS, 4=RTK, 5=float RTK, 6=dead reckoning	
9	number of satellites in use (00-99)	
10	HDOP	x.x
9	height above ellipsoid in meters	m.mm
11	M	
12	(empty field)	
13	M	

Field	Data	Units
14	age of DGPS corrections in seconds	s.s
15	DGPS reference station ID (0000-1023)	
16	Checksum	

GPVTG

02+253:00:00:00.940 \$GPVTG,19.96,T,,M,4.9,N,,K,A*39

Field	Data	Units
1	RVDAS time tag	
2	\$INVTG	
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	
12	Checksum	

GPHDT

02+253:00:00:00.941 \$GPHDT,20.62,T*23

Field	Data	Units
1	RVDAS time tag	
2	\$GPHDT	
3	Heading, degrees true	d.dd
4	T	
5	Checksum	

PSXN,22

02+253:00:00:00.942 \$PSXN,22,0.43,0.43*39

Field	Data	Units
1	RVDAS time tag	
2	\$PSXN	
3	22	
4	gyro calibration value since system start-up in degrees	d.dd
5	short term gyro offset in degrees	d.dd
6	Checksum	

PSXN,23

02+253:00:00:02.933 \$PSXN,23,0.47,0.57,20.62,0.03*0C

Field	Data	Units
1	RVDAS time tag	
2	\$PSXN	
3	23	
4	roll in degrees, positive with port side up	d.dd
5	pitch in degrees, positive with bow up	d.dd
6	Heading, degrees true	d.dd
7	heave in meters, positive down	m.mm
8	Checksum	

Ashtech GPS (ada)

The Ashtech GPS outputs three NMEA standard data strings:

- Measurement data (PBN)
- Attitude data (ATT)
- GPS position fix (GGA)

Measurement data (PBN)

```
01+324:00:00:00.064 $PASHR,PBN,172812.00,2129908.6,-1869076.7,-5694992.4,
-063:41.9477,-041:16.0918,00066.2,000.16,002.85,-000.90,08,????,02,01,01,
01*3A
```

Field	Data	Units
1	RVDAS time tag	
2	\$PASHR	
3	PBN	
4	GPS Time sec. of the week	seconds
5	Station Position: ECEF X	meters
6	Station Position: ECEF Y	meters
7	Station Position: ECEF Z	meters
8	Latitude (- = South)	deg:min
9	Longitude (- = West)	deg:min
10	Altitude	meters
11	Velocity in ECEF X	m/sec
12	Velocity in ECEF Y	m/sec
13	Velocity in ECEF Z	m/sec
14	Number of satellites used	
15	Site name	
16	PDOP	
17	HDOP	
18	VDOP	
19	TDOP	

Attitude Data (ATT)

```
01+324:00:00:00.845 $PASHR,ATT,172813.0,137.88,+000.52,-001.41,0.0029,
0.0254,0*2F
```

Field	Data	Units
1	RVDAS Time tag	
2	\$PASHR	
3	ATT	
4	GPS Time sec. Of the week	seconds
5	Heading (rel. to true North)	degrees
6	Pitch	degrees
7	Roll	degrees
8	Measurement RMS error	meters
9	Baseline RMS error	meters
10	Attitude reset flag	

GPS Position Fix – Geoid/Ellipsoid (GGA)

01+324:00:00:00.323 \$GPGGA,235959.00,6341.9477,S,04116.0918,W,1,08,00.9,
+00066,M,,M,,*77

Field	Data	Units
1	RVDAS time tag	
2	\$GPGGA	
3	UTC time at position	hhmmss.ss
4	Latitude	ddmm.mmm
5	North (N) or South (S)	
6	Longitude	ddmm.mmm
7	East (E) or West (W)	
8	GPS quality: (1 = GPS, 2 = DGPS)	
9	Number of GPS satellites used	
10	HDOP	
11	Antenna height	meters
12	M for Meters	
13	Geoidal height (no data in the sample string)	meters
14	M for meters	
15	Age of diff. GPS data (no data in the sample string)	
16	Differential reference station ID (no data in the sample string)	
17	Checksum (no delimiter before this field)	

Trimble (P-Code) GPS (PCOD)

The Trimble GPS, which formerly output Precise Position (P-Code) strings now only outputs Standard Position (Civiban) strings, outputs three NMEA standard data strings:

- Position fix (GGA)
- Latitude / longitude (GLL),
- Track and ground speed (VTG)

GGA: GPS Position Fix – Geoid/Ellipsoid

01+319:00:04:11.193 \$GPGGA,000410.312,6227.8068,S,06043.6738,W,1,06,1.0,
031.9,M,-017.4,M,,*49

Field	Data	Units
1	RVDAS Time tag	
2	\$GPGGA	
3	UTC time at position	hhmmss.sss
4	Latitude	ddmm.mmm
5	North (N) or South (S)	
6	Longitude	ddmm.mmm
7	East (E) or West (W)	
8	GPS quality: 0 = Fix not available or invalid 1 = GPS, SPS mode, fix valid 2 = DGPS (differential GPS), SPS mode, fix valid 3 = P-CODE PPS mode, fix valid	
9	Number of GPS satellites used	
10	HDOP (horizontal dilution of precision)	
11	Antenna height	meters
12	M for meters	
13	Geoidal height	meters
14	M for meters	
15	Age of differential GPS data (no data in the sample string)	

Field	Data	Units
16	Differential reference station ID (no data in the sample string)	
17	Checksum (no delimiter before this field)	

GLL: GPS Latitude/Longitude

01+319:00:04:11.272 \$GPGLL,6227.8068,S,06043.6738,W,000410.312,A*32

Field	Data	Units
1	RVDAS Time tag	
2	\$GPGLL	
3	Latitude	degrees
4	North or South	
5	Longitude	degrees
6	East or West	
7	UTC of position	hhmmss.sss
8	Status of data (A = valid)	
9	Checksum	

VTG: GPS Track and Ground Speed

01+319:00:04:11.273 \$GPVTG,138.8,T,126.0,M,000.0,N,000.0,K*49

Field	Data	Units
1	RVDAS time tag	
2	\$GPVTG	
3	Heading	degrees
4	Degrees true (T)	
5	Heading	degrees
6	Degrees magnetic (M)	
7	Ship speed	knots
8	N = knots	
9	Speed	km/hr
10	K = km per hour	
11	Checksum	

Gyro Compass (gyr1)

00+019:23:59:59.952 \$HEHRC 25034,-020*73

Field	Data	Units
1	RVDAS time tag	
2	\$HEHRC	
3	Heading XXXXX = ddd.dd	degrees
4	Rate of change SYYY S = +/-, YYY = r.rr	
5	Checksum	

ADCP Course (adcp)

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, east vector	knots
5	Ship Speed relative to reference layer, north vector	knots
6	Ship heading	degrees

Process

pCO2-merged

04+020:07:28:02.038 2004021.31097 2399.36 31.97 986.1 251.93 -0.28 243.7
50.96 0 13 Equil

(Note: Both tabs and spaces are included in this string.)

Field	Data	Units
1	RVDAS time tag	
2	PCO ₂ time tag (decimal is time of day)	yyyddd.ttt
3	Raw voltage	mV
4	Cell Temperature	°C
5	Barometer	mBar
6	CO ₂ concentration	Ppm
7	Equilibrator Temperature	°C
8	pCO ₂	μAtmos
9	Flow Rate	cc/min
10	Sample Code	
11	Valve position code	
12	Sample ID ("Equil", "Atmos", etc.)	degrees
13	TSG external temperature	°C
14	TSG salinity	PSU
15	TSG fluorometry	V
16	RVDAS true wind speed	m/s
17	RVDAS true wind direction	degrees
18	Barometric Pressure	mBars
19	Uncontaminated seawater pump flow rate	l/min
20	Speed over ground	knots
21	Course made good	degrees

tsgfl

00+075:00:00:04.467 -01.488 -01.720 02.6783 33.63748 1.002442 0.002442

Field	Data	Units
1	RVDAS time tag	
2	Internal water temperature	°C
3	Sea Surface Temperature	°C
4	Conductivity	μSiemens
5	Salinity	PSU
6	Fluorometry	V
7	Transmissivity	V

Calculations

The file *rvdascal.txt* located in the `/reports` directory contains the calibration factors for shipboard instruments. This was the file used by the RVDAS processing software.

TSG

Raw TSG data is stored as a 20 byte (character) long hex string

Bytes	Data
1-4	Sensor Temperature
5-8	Conductivity
9-14	Remote Temperature
15-17	Fluorometer voltage
18-20	Transmissometer voltage

The coefficients for temperature and conductivity sensors can be found the *rvdascal.txt* file and on the calibrations sheets in the appendix.

Calculating Temperature – ITS-90

```
T = decimal equivalent of bytes 1-4
Temperature Frequency: f = T/19 + 2100
Temperature = 1/{g + h[ln(f0/f)] + i[ln2(f0/f)] + j[ln3(f0/f)]} - 273.15
(°C)
```

Calculating Conductivity – ITS-90

```
C = decimal equivalent of bytes 5-8
Conductivity Frequency f = sqrt(C*2100+6250000)
Conductivity = (g + hf2 + if3 + jf4)/[10(1 + δt + εp)] (siemens/meter)
t = temperature (°C); p = pressure (decibars); δ = Ctcor; ε = Cpcor
```

Calculating Fluorometry Voltage (Subject to nonlinear A/D errors)

(Fluormeter Digital Signal is better)

```
f = decimal equivalent of bytes 15-17
Fluorometry Voltage = f/819
```

Calculating Transmittance

```
Vdark = 0.058 V
Vref = 4.575 V
t = decimal equivalent of bytes 18 - 20
Transmissometer Voltage (Vsignal) = t/819
% Transmittance = (Vsignal - Vdark) / (Vref - Vdark)
```

PAR

```
raw data = mV
calibration scale = 6.10 V/(μEinstiens/cm2sec)
offset (Vdark) = 2.1 mV
(raw mV - Vdark)/scale x 104 cm2/m2 x 10-3 V/mV = μEinstiens/m2sec
or
(data mV - 2.1 mV) x 1.64 (μEinstiens/m2sec)/mV = μEinstiens/m2sec
```

PIR

```
raw data = mV
calibration scale = 4.14 x 10-6 V/(W/m2)
```

$data \text{ mV} / (\text{scale} \times 10^3 \text{ mV/V}) = \text{W/m}^2$
or
 $data \text{ mV} \times 241.5 (\text{W/m}^2) / \text{mV} = \text{W/m}^2$

PSP

raw data = mV
calibration scale = $8.12 \times 10^{-6} \text{ V}/(\text{W/m}^2)$
 $data \text{ mV} / (\text{scale} \times 10^3 \text{ mV/V}) = \text{W/m}^2$
or
 $data \text{ mV} \times 123.2 (\text{W/m}^2) / \text{V} = \text{W/m}^2$

Acquisition Problems and Events

This section lists problems with acquisition noted during this cruise including instrument failures, data acquisition system failures and any other factor affecting this data set. The format is ddd:hh:mm (ddd is year-day, hh is hour, and mm is minute). Times are reported in GMT.

It was discovered on the previous cruise that our data logging system eltanin, had some serious problems. During the last cruise we did what we could to diagnose and isolate those problems. We believed at the onset of this cruise that the only time the loggers had errors were when we ran rsync jobs that wrote data to the same disks that the loggers were writing to. At the beginning of the cruise we arranged all of our daily processes so that there would be no rsync jobs writing to the logger computer. We believed this would solve the problem. Two days into the cruise, we discovered that the problem could also be triggered by other things (gzip to name one). Many of the errors listed in this log are due to this problem. That being said, I should mention that the frequency of the errors and the duration of the errors was minimal, all total we didn't lose more than an hour of navigation. The instrument most effected by the logger errors was the Simrad ek500. There are holes where as much as 3 hours of data are missing. The majority of the gaps are in the first four days of the cruise. After that they become less frequent and of much shorter duration. The logger errors injected massive amounts of control characters into the data. The ek500 data on the data distribution has been cleaned by hand to remove the bad data. If you have any questions write paul.huckins@usap.gov.

Start	End	Description
054 07:30		Depart McMurdo ice pier; data collection begins.
054:14:00		Replaced transmissometer in underway seawater system with "WetLabs S/N: CST-423PR. Updated coefficients files on fram and eltanin
055:02:41		Simrad logger crashed
055:03:16		Stop and restart all loggers to clear ek500 errors
055:03:35		Simrad ek500 errors again
055:??:??		Transmissometer changed. Remove CST-422PR and install CST-423PR (lens was fogging up)
055:06:25		Kill and restart ek500
055:02:41		Kill and restart ek500
055:10:16		Stop and restart all loggers hoping to clear rv_tsg errors
055:02:41		Discovered bad info in inst.coeff file. This file was not used in calibrating data. It was replaced with correct data. (the error was caused by someone on nbp0306 who forgot to check the file into RCS)
056:00:10		Both the ahstech and PCOD loggers are crashed. Stopping them and re-starting them solved the problem. Will have to clean the nav files and re-process the data for jd-056
056:00:10		Ek500 on fram also crashed, was preoccupied with eltanin problems and did not notice till later.
056:12:04		Ashtech Crashed. Receiver reset all ok
057:18:18		Seawater to transmissometer and fluorometer shut off in order to clean transmissometer.
057:20:30		Removed transmissometer S/N:CST423PR from service
057:20:40		Installed transmissometer S/N:CST577DR and put in service.

		(Instrument coefficients adjusted accordingly)
063:11:20		Discovered ek500 logger crashed at 09:30. Reset at 11:20
069:00:32		Seapath, ashtech and seawater (eng1) loggers all crashed. Shut off briefly and re-started. All seem ok. Will have to clean files.
080:00:26		We have stopped in the ice for a science party to go out. I am re-booting fram and eltanin back to a previous revision kernel of linux in hopes that it will cure the logging problems.
078:00:31	078:04:10	Tested underway fluorometer with deionized water then replaced the dessicant after discovering fogging on the flow through cell
080:00:45		Re-booted fram and eltanin and loggers still unstable
092:00:22	092:00:35	Loggers had errors, shut off loggers multiple times. Finally shut off rvdas and restarted. All ok
093:09:10	093:09:27	Shut off eltanin and switched to fram as logger and displayer.
093:23:05		Discovered that the Sound Velocity Probe had rebooted at 09:25 (probably when the DAS was cut over to fram) no data from 09:25 to 23:05
094:07:10		We got a HUGE spike in the Seapath data. The Ets have determined that it was isolated to the seapath. The lat and long values shot way out of range for 6 minutes causing it to look like the boat was going 29knots/hr.

Appendix: Sensors and Calibrations

NBP0402 Shipboard Sensors

Sensor	Description	Serial #	Last Calibration Date	Status
Meteorology & Radiometers				
Port Anemometer	RM Young 5106	WM46262	12/25/03	Collect
Stbd Anemometer	RM Young 5106	WM51143	06/15/03	Collect
Barometer	RM Young 61201	01705	07/04/03	Collect
Air Temp/Rel. Hum.	RM Young 41372LC	06134	05/22/03	Collect
Mast PRR	BSI PRR-610			Not used
UW PRR	BSI PRR-600			Not used
PIR (Pyrgeometer)	Eppley PIR	32845F3	07/03/03	Collect
PSP (Pyranometer)	Eppley PSP	32850F3	07/03/03	Collect
Mast PAR	BSI QSR-240	6357	06/24/03	Collect
GUV			N/A	Not used
PUV				Not used
Underway				
TSG	SeaBird SBE21	218091-1390	05/29/03	Collect
TSG Remote Temp	SeaBird 3-01/S	034071	05/22/03	Collect
Fluorometer	Turner 10-AU-005 Lamp: daylight 10-045; ref. filter: 10-052, em. filter: 10-051, ex. filter: 10-050	5651 FRTD	N/A	Collect
Transmissometer	WET Labs C-Star	CST-423PR	10/15/03	Collect
Magnetometer	EG&G G-877	0040		Not used
Gravimeter	LaCoste & Romberg Gravity Meter			Collect
Bathymetry	Simrad EK500	3001	11/1/95	Collect
Bathymetry	Knudsen 320B/R			Not used
Bathymetry	Bathy 2000			Collect
Other				
Primary GPS	Simtex Seapath 200	2253	N/A	Collect
Attitude GPS	Ashtech 12	700273F2114 FW 7B13-D1-C21	N/A	Collect

NBP0402 CTD Sensors:

Sensor	Description	Serial #	Last Calibration Date	Status
CTD Fish	SeaBird model SBE 9+	09P10716-0377	6/03/03 at Scripps	Collect
CTD Fish Pressure	Paroscientific model 410K-105 pressure sensor	58949	6/03/03 at Scripps	Collect
CTD Deck Unit	SeaBird model SBE 11+	11P19858-0490		Collect
Primary Temperature Sensor	SeaBird model 3+	03P2367	9/27/03	Collect
Secondary Temperature Sensor	SeaBird model 3+	03P2299	9/27/03	Collect
Primary Conductivity Sensor	SeaBird model 4C	41799	7/01/03	Collect
Secondary Conductivity Sensor	SeaBird model 4C	7/01/03	7/01/03	Collect
Dissolved Oxygen Sensor	SeaBird model SBE-43	0152	6/30/03	Collect
Transmissometer	WET Labs CST-423PR, C-Star	CST-439DR	7/21/03	Collect
Fluorometer	WET Labs AFLT	AFLT-009	10/14/03	Collect
PAR Sensor	WET Labs QSP-200L4S	4361	10/24/03	Collect

Other CTD information:

CTD Pump	051609 1.3K LV	12/2/02	Primary, Removed 03/15/04
CTD Pump	051265 3.0K	10/31/02	Primary, Installed 03/15/04
CTD Pump	050889 3.0K	10/31/02	Secondary
<u>Pinger, 12khz</u>	5118	03/08/03 Batt. 2/29/04 Batt	Removed 2/28/04, weak output. Reinstalled 3/28/04.
<u>Pinger, 12khz</u>	5117	04/01/03 Batt 03/29/04 Batt	Installed 2/28/04. Removed 3/28/04, weak output.
<u>Bottom Contact Switch</u>	#1	N/A	Removed 3/6/04 and cleaned. Reinstalled 3/10/04
<u>Bottom Contact Switch</u>	#2	N/A	Installed 3/6/04, Removed 3/10/04 and cleaned
<u>Slip-Ring Assembly</u>	23.265	N/A	Removed: 3/27/04
<u>Slip-Ring Assembly</u>	1.406	N/A	Installed: 3/27/04

Meteorology System

Anemometer (Port)**RM Young Anemometer Calibration, Model 05106**

S/N: 45262

Date: 25-Feb-03

Cal'd By: Bruce Felix

Clockwise Cal Motor RPM	Calculated Windspeed m/s	Measured Windspeed m/s	Delta m/s	Knots
0	0.00	0.0	0.0	0
200	0.98	0.9	0.1	1.904
500	2.45	2.3	0.2	4.76
1000	4.90	4.8	0.1	9.52
1500	7.35	7.3	0.0	14.28
2000	9.80	9.8	0.0	19.04
3000	14.70	14.8	-0.1	28.56
4000	19.60	19.8	-0.2	38.08
5000	24.50	24.8	-0.3	47.6
6000	29.40	29.8	-0.4	57.12
7000	34.30	34.7	-0.4	66.64
8000	39.20	39.7	-0.5	76.16
9000	44.10	44.7	-0.6	85.68
10000	49.00	49.6	-0.6	95.2
12000	58.80	59.4	-0.6	114.24

Direction	Measured Direction	Delta Direction
0	0	0
30	28.5	1.5
60	59	1
90	90	0
120	120	0
150	149	1
180	179	1
210	209	1
240	240	0
270	269.5	0.5
300	300	0
330	330	0
0	0	0

Note: Delta direction should not exceed + or - 3 degrees.

Counter Clockwise Cal Motor RPM	Calculated Windspeed m/s	Measured Windspeed m/s	Delta m/s
0	0.00	0.0	0.0
200	0.98	0.9	0.1
500	2.45	2.3	0.2
1000	4.90	4.8	0.1
1500	7.35	7.3	0.0
2000	9.80	9.8	0.0
3000	14.70	14.8	-0.1
4000	19.60	19.8	-0.2
5000	24.50	24.8	-0.3
6000	29.40	29.8	-0.4
7000	34.30	34.7	-0.4
8000	39.20	39.7	-0.5
9000	44.10	44.7	-0.6
10000	49.00	49.7	-0.6
12000	58.80	59.5	-0.7

Caution: Do Not exceed 12000 rpm during Wind Speed test.

Wind Speed Threshold < 2.9 gm? ☒ Yes
 Wind Direction Threshold < 30 gm? ☒ Yes

Additional Comments

Note: Delta Windspeed should not exceed + or - 0.3 m/s for 0 - 5000 rpm

Anemometer (Starboard)**RM Young Anemometer Calibration, Model 05106**

S/N: 51143

Date: 15-Jun-03

Cal'd By: S. Blackman

Clockwise Cal Motor RPM	Calculated Windspeed m/s	Measured Windspeed m/s	Delta m/s	knots
0	0.00	0.0	0.0	0.0
200	0.98	0.9	0.1	1.9
500	2.45	2.3	0.2	4.8
1000	4.90	4.8	0.1	9.5
1500	7.35	7.4	-0.1	14.3
2000	9.80	9.8	0.0	19.0
3000	14.70	14.8	-0.1	28.6
4000	19.60	19.8	-0.2	38.1
5000	24.50	24.8	-0.3	47.6
6000	29.40	29.7	-0.3	57.1
7000	34.30	34.7	-0.4	66.6
8000	39.20	39.7	-0.5	76.2
9000	44.10	44.7	-0.6	85.7
10000	49.00	49.6	-0.6	95.2
12000	58.80	59.5	-0.7	114.2

Direction	Measured Direction	Delta Direction
0	0	0
30	29	1
60	59	1
90	89	1
120	120	0
150	150	0
180	180	0
210	210	0
240	242	-2
270	273	-3
300	302	-2
330	332	-2
0	0	0

Note: Delta direction should not exceed + or - 3 degrees.

Counter Clockwise Cal Motor RPM	Calculated Windspeed m/s	Measured Windspeed m/s	Delta m/s
0	0.00	0.1	-0.1
200	0.98	0.9	0.1
500	2.45	2.3	0.2
1000	4.90	4.8	0.1
1500	7.35	7.3	0.0
2000	9.80	9.8	0.0
3000	14.70	14.8	-0.1
4000	19.60	19.8	-0.2
5000	24.50	24.8	-0.3
6000	29.40	29.8	-0.4
7000	34.30	34.7	-0.4
8000	39.20	39.7	-0.5
9000	44.10	44.7	-0.6
10000	49.00	49.6	-0.6
12000	58.80	59.5	-0.7

Caution: Do Not exceed 12000 rpm during Wind Speed test.

Wind Speed Threshold < 2.9 gm?

Wind Direction Threshold < 30 gm?

Additional Comments

This instrument does not appear to have been used. It's new cal date should start with it's installation.

Note: Delta Windspeed should not exceed + or - 0.3 m/s for 0 - 5000 rpm

Temperature Sensor

Meteorological Instruments

Temperature Sensor Calibration ReportCustomer: *Raytheon Technical Services Co*

Test Number: 35222

Customer PO: RM93195.50

Test Date: 22 May 2003

Sales Order: 6552

Test Sensor:

Model: 41372LC

Serial Number: 6134

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 $\pm 0.1^\circ$ Celsius.

Bath Temperature (degrees C)	Current Output (milliamps)	Indicated (1) Temperature (degrees C)
-49.93	4.011	-49.93
0.03	12.002	0.01
50.02	20.002	50.01

(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 InstrumentSerial # NIST Test Reference

Brooklyn Thermometer Model 43-FC
 Brooklyn Thermometer Model 22332-D5-FC
 Brooklyn Thermometer Model 2X400-D7-FC
 Keithley Multimeter Model 191

8006-118 204365
 25071 249763
 77532 228060
 15232 234027

Tested By:

R.M. YOUNG COMPANY 2801 Aero Park Drive, Traverse City, Michigan 49686 USA
 Tel: 231-946-3980 Fax: 231-946-4772 Email: met.sales@youngusa.com

PIR**THE EPPLEY LABORATORY, INC.**

12 Sheffield Ave. P.O. Box 419, Newport, RI 02840 USA

Telephone 401-847-1020

Fax 401-847-1031

Email: eplab@mail.bbsnet.com

Internet: www.eppleylab.com

Scientific Instruments
for Precision Measurements
Since 1911**STANDARDIZATION OF
EPPLEY PRECISION INFRARED RADIOMETER
Model PIR**

Serial Number: 32845F3

Resistance: 739 Ω at 23 $^{\circ}\text{C}$
Temperature Compensation Range: -20 to 40 $^{\circ}\text{C}$

This pyrgeometer has been compared with Precision Infrared Radiometer, Serial Number 29326F3 in Eppley's Blackbody Calibration System under radiation intensities of approximately 200 watts meter⁻² and an average ambient temperature of 24 $^{\circ}\text{C}$.

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

$$4.14 \times 10^{-6} \text{ volts/watts meter}^{-2}$$

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⁻². 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.

Shipped to:
Raytheon Polar Services
Port Hueneme, CA

Date of Test: June 9, 2003

In Charge of Test: *R. T. Jensen*S.O. Number: 59471
Date: July 3, 2003Reviewed by: *Thomas D. Kuh*

Remarks:

PSP**THE EPPLEY LABORATORY, INC.**

12 Sheffield Ave., P.O. Box 419, Newport, RI 02840 USA

Telephone: 401-847-1020

Fax: 401-847-1031

Email: eplab@mail.bbsnet.com

Internet: www.eppleylab.com



Scientific Instruments
for Precision Measurements
Since 1917

**STANDARDIZATION
OF
EPPLEY PRECISION SPECTRAL PYRANOMETER
Model PSP**

Serial Number: 32850F3

Resistance: 706 Ω at 23 $^{\circ}\text{C}$ Temperature Compensation Range: -20 to 40 $^{\circ}\text{C}$

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). The adopted calibration temperature is 25 $^{\circ}\text{C}$.

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

$$8.12 \times 10^{-6} \text{ volts/watts meter}^{-2}$$

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 $\pm 0.5\%$ 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 Ninth International Pyrheliometric Comparisons (IPC IX) at Davos, Switzerland in September-October 2000.

Useful conversion facts: 1 cal cm⁻² min⁻¹ = 697.3 watts meter⁻²
1 BTU/ft²-hr⁻¹ = 3.153 watts meter⁻²

Shipped to:
Raytheon Services
Port Hueneme, CA

Date of Test: July 3, 2003

In Charge of Test: *R.T. Egan*

S.O. Number: 59471
Date: July 3, 2003

Reviewed by: *Thomas D. Kuk*

Remarks: Sensitivity before repainting 7.97

PAR

Installed 11/2/03 QSR03 GAT

Biospherical Instruments Inc.

CALIBRATION CERTIFICATE

Calibration Date 6/24/03
 Model Number QSR-240
 Serial Number 6357
 Operator TPC
 Standard Lamp 98700(5/19/01)
 Probe Excitation Voltage Range: 5 to 18 VDC(+)

Output Polarity: Positive

Probe Conditions at Calibration (in air):

Calibration Voltage: 5 VDC(+)

Probe Current: 7.1 mA

Probe Output Voltage:

Probe Illuminated 94.7 mV
 Probe Dark 2.1 mV
 Probe Net Response 92.6 mV

Corrected Lamp Output:

Output In Air (same condition as calibration):

9.14E+15 quanta/cm²sec
0.015 uE/cm²sec

Calibration Factor:

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

Dry: 1.01E-17 V/(quanta/cm²sec)
6.10E+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

TSG Calibration Files

Underway Conductivity Sensor

Installed 11/1/03 21:40 GM

SEA-BIRD ELECTRONICS, INC.

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

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

SENSOR SERIAL NUMBER: 1390
CALIBRATION DATE: 29-May-03

SBE21 CONDUCTIVITY CALIBRATION DATA
PSS 1978: C(35,15,0) = 4.2914 Siemens/meter

GHIJ COEFFICIENTS

g = -3.92868160e+000
h = 4.69806858e-001
i = 7.64098134e-004
j = -1.60788378e-005
CPcor = -9.5700e-008 (nominal)
CTcor = 3.2500e-006 (nominal)

ABCDM COEFFICIENTS

a = 3.67483151e-002
b = 4.29412267e-001
c = -3.91316767e+000
d = -9.02523180e-005
m = 2.1
CPcor = -9.5700e-008 (nominal)

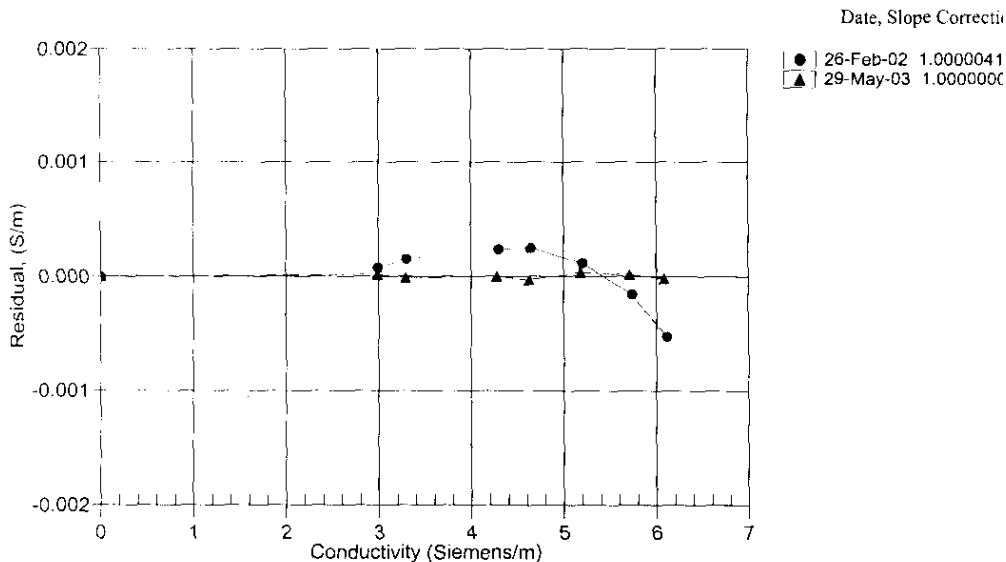
BATH TEMP (ITS-90)	BATH SAL (PSU)	BATH COND (Siemens/m)	INST FREQ (kHz)	INST COND (Siemens/m)	RESIDUAL (Siemens/m)
22.0000	0.0000	0.00000	2.88542	0.00000	0.00000
1.0000	34.8296	2.97699	8.42198	2.97701	0.00001
4.4999	34.8298	3.28586	8.79780	3.28585	-0.00001
15.0001	34.8286	4.27297	9.90293	4.27297	-0.00000
18.4998	34.8281	4.61975	10.26266	4.61971	-0.00003
24.0000	34.8272	5.18007	10.81853	5.18010	0.00003
28.9999	34.8259	5.70370	11.31305	5.70372	0.00002
32.5000	34.8235	6.07710	11.65274	6.07708	-0.00002

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



Underway Temperature Sensor

installed 11/5/03 21:40 GMT

SEA-BIRD ELECTRONICS, INC.

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

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

SENSOR SERIAL NUMBER: 1390
CALIBRATION DATE: 29-May-03SBE21 TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

ITS-90 COEFFICIENTS

$g = 4.21019024e-003$
 $h = 5.94640281e-004$
 $i = 4.44891723e-006$
 $j = -1.86469051e-006$
 $f_0 = 1000.0$

ITS-68 COEFFICIENTS

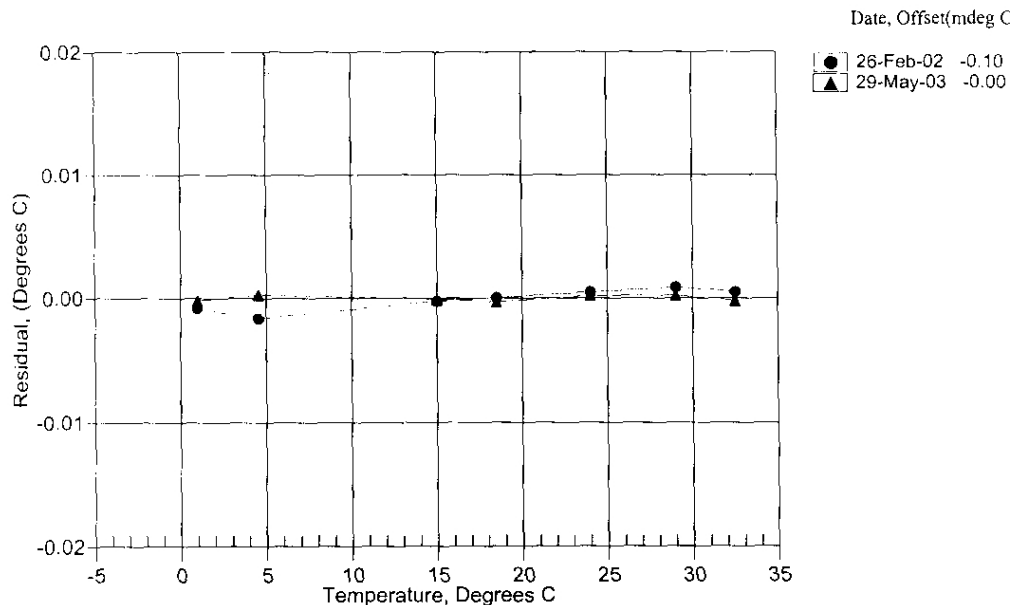
$a = 3.64763709e-003$
 $b = 5.81167551e-004$
 $c = 9.81916346e-006$
 $d = -1.86421698e-006$
 $f_0 = 2600.237$

BATH TEMP (ITS-90)	INSTRUMENT FREQ (Hz)	INST TEMP (ITS-90)	RESIDUAL (ITS-90)
1.0000	2600.237	0.9998	-0.00016
4.4999	2814.700	4.5002	0.00028
15.0001	3533.544	15.0000	-0.00008
18.4998	3799.584	18.4995	-0.00029
24.0000	4245.942	24.0002	0.00022
28.9999	4682.643	29.0001	0.00022
32.5000	5006.484	32.4998	-0.00019

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

$$\text{Temperature ITS-68} = 1/\{a + b[\ln(f_0/f)] + c[\ln^2(f_0/f)] + d[\ln^3(f_0/f)]\} - 273.15 \text{ (}^\circ\text{C)}$$
Following the recommendation of JPOTS: T_{68} is assumed to be $1.00024 * T_{90}$ (-2 to 35 $^\circ\text{C}$)

Residual = instrument temperature - bath temperature



Underway Remote Temperature Sensor**SEA-BIRD ELECTRONICS, INC.**

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

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

SENSOR SERIAL NUMBER: 4071
CALIBRATION DATE: 22-May-03SBE3 TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

ITS-90 COEFFICIENTS

$g = 4.35895089e-003$
 $h = 6.40216931e-004$
 $i = 2.15751732e-005$
 $j = 1.62828152e-006$
 $f0 = 1000.0$

ITS-68 COEFFICIENTS

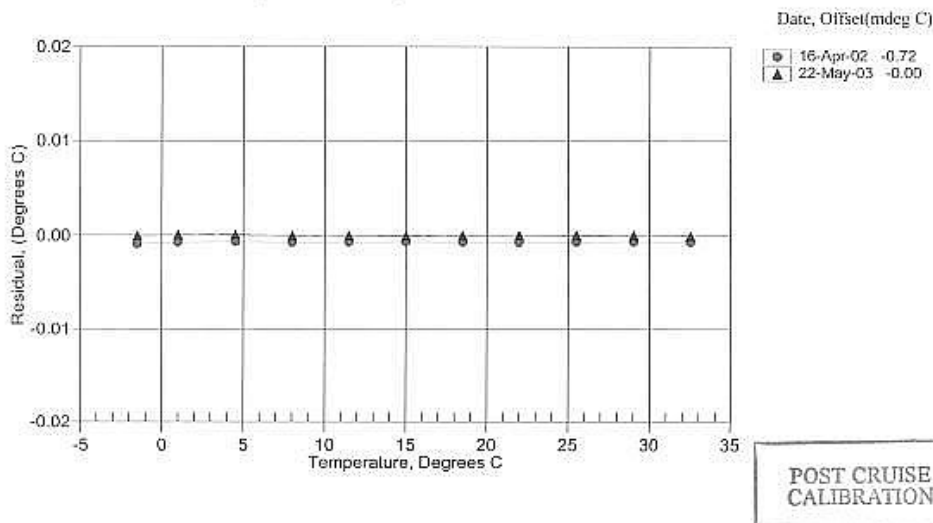
$a = 3.68120856e-003$
 $b = 5.98945763e-004$
 $c = 1.62500352e-005$
 $d = 1.62975230e-006$
 $f0 = 2991.383$

BATH TEMP (ITS-90)	INSTRUMENT FREQ (Hz)	INST TEMP (ITS-90)	RESIDUAL (ITS-90)
-1.4997	2991.383	-1.4998	-0.00005
1.0003	3164.148	1.0004	0.00005
4.5003	3418.027	4.5004	0.00007
8.0003	3686.289	8.0003	-0.00005
11.5003	3969.362	11.5003	-0.00003
15.0003	4267.632	15.0003	-0.00003
18.5003	4581.492	18.5003	-0.00001
22.0003	4911.320	22.0003	0.00001
25.5003	5257.484	25.5003	0.00004
29.0003	5620.337	29.0003	0.00003
32.5003	6000.224	32.5003	-0.00004

$$\text{Temperature ITS-90} = 1 / \{ g + h [\ln(T_0/T)] + i [\ln^2(T_0/T)] + j [\ln^3(T_0/T)] \} - 273.15 \text{ (}^\circ\text{C)}$$

$$\text{Temperature ITS-68} = 1 / \{ a + b [\ln(T_0/T)] + c [\ln^2(T_0/T)] + d [\ln^3(T_0/T)] \} - 273.15 \text{ (}^\circ\text{C)}$$
Following the recommendation of JPOTS: T_{es} is assumed to be $1.00024 * T_{\text{sn}}$ (-2 to 35 $^\circ\text{C}$)

Residual = instrument temperature - bath temperature



Underway Transmissometer #1

Wetlabs C-Star Transmissometer
N.B.Palmer Onboard Calibration Sheet

Calibration Date: 10/15/03

Serial Number: CST-422PR

Technician: Walter Gallagher / Floyd Trujillo

Use the following table to enter voltages when performing an annual calibration of the instrument:

$Y_0 = V_d$	0.058	Voltage Blocked
$A_0 = V_{air}$	4.711	Voltage in air
$W_0 = V_{ref}$	4.575	Voltage in pure filtered H ₂ O from the Nanopure system.
Cal. Temp of Water	20.0	Temperature of the water during calibration. (Centigrade)
Ambient Temp	21.5	Air temperature during the calibration. (Centigrade)

The following equation is used by RVDas to obtain % of Transmittance:

$$\% \text{ Transmission} = 100\% * (V_{sig} - V_d) / (V_{ref} - V_d) \quad V_{sig} = \text{Signal Voltage at any point in time.}$$

Use the following table to enter measured voltages when putting the instrument in use:

Note: Use the system that the instrument is being installed in to measure the voltage.
 (i.e., CTD: Use the CTD Deck unit and read the voltage on the CTD Computer with the system on.)
Make sure the lenses are clean and dry!

Date:

Technician:

System:

	Value	Comments
$Y_1 = V_{dark} \text{ (current)}$	0.058	Current measured blocked voltage.
$A_1 = V_{air} \text{ (current)}$	4.884	Current measured voltage in air.
T_w	100%	%Transmission in pure water.

Use the following equations to obtain the M and B constants for Seasave for both the CTD and Thermosalinagraph:

(Select Chelsea/Seatech/ Wetlabs C-Star in *Seasave for Windows* or *Transmissometer in Season for DOS*).
 (Do NOT select Beam Transmissometer or WetLabs AC3)

$$M = (T_w / W_0) * (A_0 - Y_0) / (A_1 - Y_1)$$

$$B = -M Y_1$$

$$M = (100 / 4.575) * (4.711 - 0.058) / (4.884 - 0.058) \quad B = -21.857 * .058$$

$$M = 21.073$$

$$B = -1.222$$

$$\text{Path Length (M)} = 0.250$$

Underway Transmissometer #2

PO Box 518
620 Applegate St.
Philomath, OR 97370



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

C-Star Calibration

Date 12/23/03	Customer National Science Foundation	Work order 006
Job # 0012016	S/N# CST-423PR	Pathlength 25 cm

	Analog meter
V_d	0.059 V
V_{air}	4.824 V
V_{ref}	4.792 V

Temperature of calibration water	22.7 °C
Ambient temperature during calibration	20.1 °C

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

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.

Underway Transmissometer #3

PO Box 518
620 Applegate St.
Philomath, OR 97370



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

C-Star Calibration

Date	1/12/04	Customer	National Science Foundation	Work order	002
Job #	0201020	S/N#	CST-557DR	Pathlength	25 cm

	Analog meter
V_d	0.059 V
V_{air}	4.813 V
V_{ref}	4.708 V

Temperature of calibration water	23.3 °C
Ambient temperature during calibration	23.7 °C

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

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.

Gravity Tie Meter**Gravity Tie Spreadsheet**

The fields outlined in **BOLD MUST BE FILLED IN** for this spreadsheet to operate properly.
The automatically calculated values show up in the shaded fields.

Date: **2/19/2004**

Reference Code Numbers:

Location: **McMurdo Station, Antarctica**

Station: Thiel Base Station

Latitude: 77 deg 50' 55.9068" S

Longitude: 166 deg 40' 45.9629" E

Elevation: 46.21 meters

Gravity: 982970.52

	Value	Time (GMT)
Ship's meter before gravity tie (Digital Gravity)	10600.4	19:48
Ship's meter after gravity tie (Digital Gravity)	10600.6	21:59
Average	10600.5	
Ship Gravimeter's Calibration Constant	1.0046	
Corrected ship's meter (Digital Gravity)	10649.3	

	Value	Time (GMT)
Ship's meter before gravity tie (serial, RVDAS)	10649.2	19:49
Ship's meter after gravity tie (serial, RVDAS)	10649.3	22:00
Average (for comparison check only)	10649.3	

Portable Gravimeter Correction Divisor

1.007937

Station	Value	Time (GMT)	Temp	Date	OBS mgal, averaged
Pier measurement 1	6547.98	20:27	54	February 19, 2004	
Pier measurement 2	6547.92	20:29	54	February 19, 2004	6496.35
Pier measurement 3	6547.83	20:30	54	February 19, 2004	
Average	6547.91				
Station measurement 1	6540.54	21:22	54	February 19, 2004	
Station measurement 2	6540.54	21:25	54	February 19, 2004	6489.03
Station measurement 3	6540.51	21:26	54	February 19, 2004	
Average	6540.53				
Pier measurement 4	6547.84	21:49	54	February 19, 2004	
Pier measurement 5	6547.94	21:51	54	February 19, 2004	6496.34
Pier measurement 6	6547.93	21:53	54	February 19, 2004	
Average	6547.90				

Gravity offset from last tie 972326.93
Drift since last tie 0.75

OBS Differences

Station to Pier (1, 2, & 3 averaged)
Station to Pier (4, 5, & 6 averaged)
Averaged Differences
Gravity at pier
Elevation of pier above gravimeter, meters
Earth differential gravity, mgal/meter
Gravity at ship's gravimeter
Gravity Offset

7.32
7.32
7.32
982977.84
-3.0
0.3
982976.94
972327.68

Comments

Tie done by Sheldon Blackman & Mike Carpenter Due to very unstable readings on the ice pier, measurements were done approx. 100m across the ice pier bridge on solid ground at approx. the same vertical elevation as the ice pier and line up with the ship's onboard gravimeter. The readings at this location were very close to the best measurement we could get at the ice pier.

CTD Fish/Pressure sensor

S/N: Pressure Sensor-Fish
58949-0377
Cal Date: 03-June-2003

0305N377CON.txt

T1: 2.998410e+01
T2: -2.451935e-04
T3: 3.711743e-06
T4: 2.102236e-09
T5: 0.000000e+00

C1: -4.839620e+04
C2: 3.519636e-01
C3: 8.922267e-03

D1: 3.977913e-02
D2: 3.026373e-05
AD590M: 1.250000e-02
AD590B: -1.000000e+01

Slope: 1.00000000
Offset: 0.00000

Scripps
Pressure
Sensor
Calibration

CTD Temperature (Primary)**SEA-BIRD ELECTRONICS, INC.**

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

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

SENSOR SERIAL NUMBER: 2367
CALIBRATION DATE: 27-Sep-03SBE3 TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

ITS-90 COEFFICIENTS

$g = 4.33464895e-003$
 $h = 6.43060868e-004$
 $i = 2.37289331e-005$
 $j = 1.30187396e-006$
 $f_0 = 1000.0$

ITS-68 COEFFICIENTS

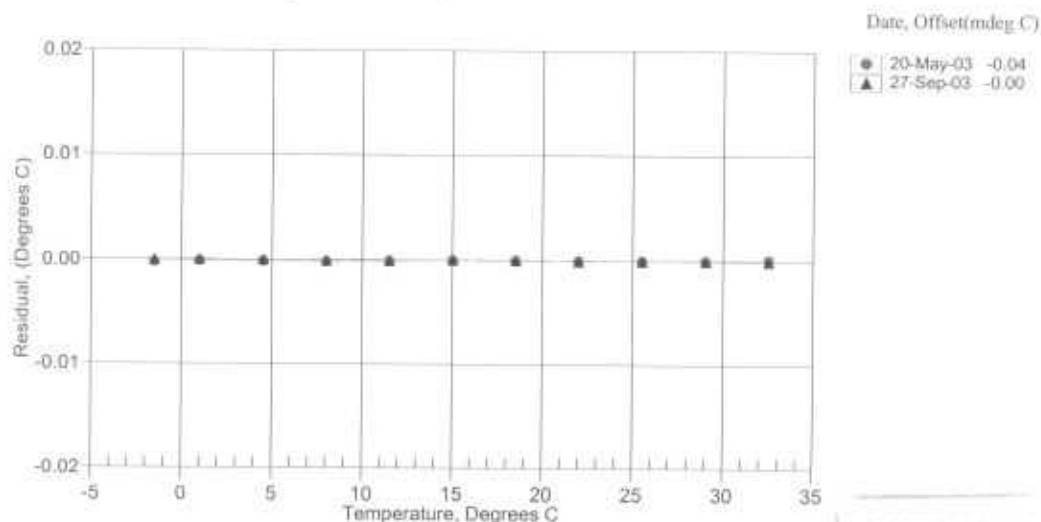
$a = 1.68121404e-003$
 $b = 6.00894693e-004$
 $c = 1.64857748e-005$
 $d = 2.30345916e-006$
 $f_0 = 2865.855$

BATH TEMP (ITS-90)	INSTRUMENT FREQ (Hz)	INST TEMP (ITS-90)	RESIDUAL (ITS-90)
-1.5001	2865.855	-1.5001	-0.00003
0.9999	3030.818	0.9999	0.00004
4.4999	3273.179	4.4999	0.00001
7.9999	3529.208	7.9999	-0.00003
11.4999	3799.277	11.4998	-0.00006
14.9999	4083.759	15.0000	0.00006
18.4999	4382.978	18.4999	0.00003
21.9999	4697.281	21.9999	-0.00004
25.4999	5027.007	25.4999	-0.00000
28.9999	5372.458	28.9999	0.00001
32.4999	5733.932	32.4999	-0.00000

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

$$\text{Temperature ITS-68} = 1/[a + b[\ln(f_0/f)] + c[\ln^2(f_0/f)] + d[\ln^3(f_0/f)]] - 273.15 \text{ (}^\circ\text{C)}$$
Following the recommendation of JPOTS: T_{90} is assumed to be $1.00024 * T_{90}$ (-2 to 35 $^\circ\text{C}$)

Residual = instrument temperature - bath temperature

POST CALIB
CALIBRATION

CTD Temperature (Secondary)**SEA-BIRD ELECTRONICS, INC.**

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

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

SENSOR SERIAL NUMBER: 2299
CALIBRATION DATE: 27-Sep-03SBE3 TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

ITS-90 COEFFICIENTS

$g = 4.33206829e-003$
 $h = 6.44077287e-004$
 $i = 2.38113582e-005$
 $j = 2.35121832e-006$
 $f_0 = 1000.0$

ITS-68 COEFFICIENTS

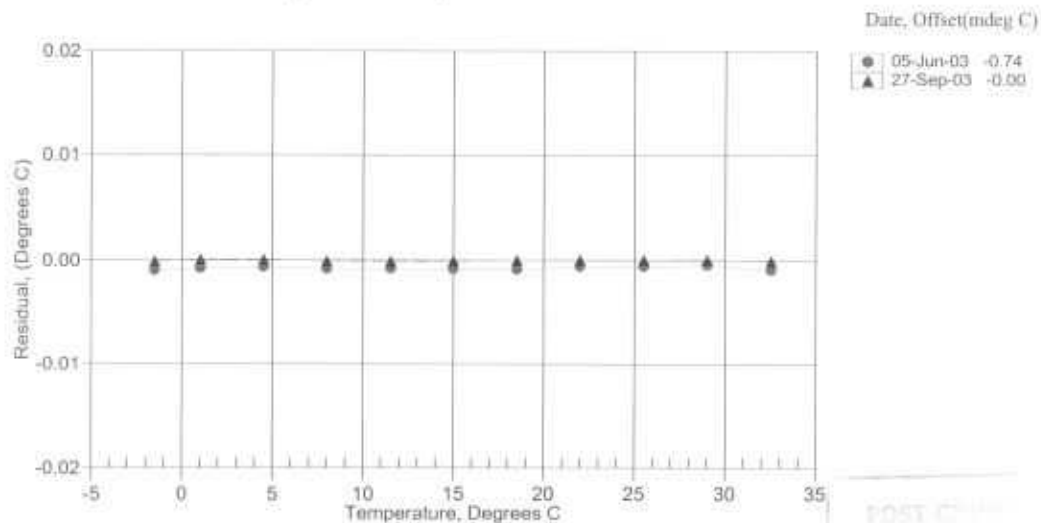
$a = 3.68121475e-003$
 $b = 6.02099371e-004$
 $c = 1.64548249e-005$
 $d = 2.35280952e-006$
 $f_0 = 2848.680$

BATH TEMP (ITS-90)	INSTRUMENT FREQ (Hz)	INST TEMP (ITS-90)	RESIDUAL (ITS-90)
-1.5001	2848.680	-1.5002	-0.00008
0.9999	3012.322	1.0000	0.00009
4.4999	3252.697	4.5000	0.00008
7.9999	3506.574	7.9999	-0.00003
11.4999	3774.328	11.4998	-0.00008
14.9999	4056.313	14.9999	-0.00004
18.4999	4352.864	18.4999	0.00001
21.9999	4664.308	21.9999	0.00003
25.4999	4990.961	25.4999	0.00002
28.9999	5333.134	29.0000	0.00006
32.4999	5691.099	32.4998	-0.00006

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

$$\text{Temperature ITS-68} = 1 / \{ a + b[\ln(f_0/f)] + c[\ln^2(f_0/f)] + d[\ln^3(f_0/f)] \} - 273.15 \text{ (}^\circ\text{C)}$$
Following the recommendation of JPOTS, T_{90} is assumed to be $1.00024 * T_{90}$ (-2 to 35 $^\circ\text{C}$)

Residual = instrument temperature - bath temperature



Conductivity (Primary)**SEA-BIRD ELECTRONICS, INC.**

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

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

SENSOR SERIAL NUMBER: 1799
CALIBRATION DATE: 01-Jul-03SBE4 CONDUCTIVITY CALIBRATION DATA
PSS 1978: C(35,15,0) = 4.2914 Siemens/meter

GHJ COEFFICIENTS:

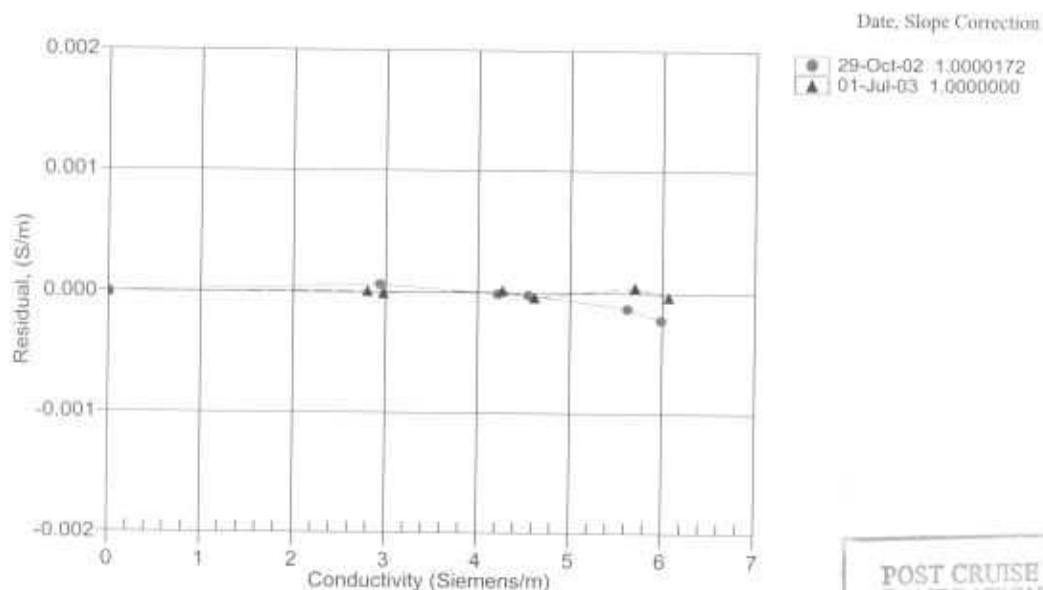
$g = -4.35287877e+000$
 $h = 5.27646028e-001$
 $i = -6.70690506e-004$
 $j = 6.01449704e-005$
 $CPcor = -9.5700e-008$ (nominal)
 $CTcor = 3.2500e-006$ (nominal)

ABCDM COEFFICIENTS:

$a = 8.10768573e-007$
 $b = 5.25232434e-001$
 $c = -4.34456430e+000$
 $d = -7.87344935e-005$
 $m = 5.3$
 $CPcor = -9.5700e-008$ (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	2.87612	0.00000	0.00000
-1.0003	34.7760	2.80161	7.84397	2.80162	0.00001
0.9997	34.7766	2.97287	8.04816	2.97286	-0.00001
14.9997	34.7771	4.26728	9.44942	4.26730	0.00002
18.4997	34.7777	4.61377	9.78981	4.61373	-0.00004
28.9997	34.7755	5.69636	10.78292	5.69640	0.00005
32.4997	34.7703	6.06884	11.10342	6.06881	-0.00003

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

$$\text{Conductivity} = (af^m + bf^2 + c + dt) / [10(1 + \epsilon p)] \text{ Siemens/meter}$$
 $t = \text{temperature}[^{\circ}\text{C}]; p = \text{pressure}[\text{decibars}]; \delta = CTcor; \epsilon = CPcor;$
 $\text{Residual} = (\text{instrument conductivity} - \text{bath conductivity}) \text{ using } g, h, i, j \text{ coefficients}$


Conductivity (Secondary)**SEA-BIRD ELECTRONICS, INC.**

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

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

SENSOR SERIAL NUMBER: 1852
CALIBRATION DATE: 01-Jul-03SBE4 CONDUCTIVITY CALIBRATION DATA
PSS 1978: C(35,15,0) = 4.2914 Siemens/meter

GHJ COEFFICIENTS

$g = -4.00915022e+000$
 $h = 5.12027649e-001$
 $i = -5.99719365e-004$
 $j = 5.68870677e-005$
 $CPcor = -9.5700e-008$ (nominal)
 $CTcor = 3.2500e-006$ (nominal)

ABCDM COEFFICIENTS

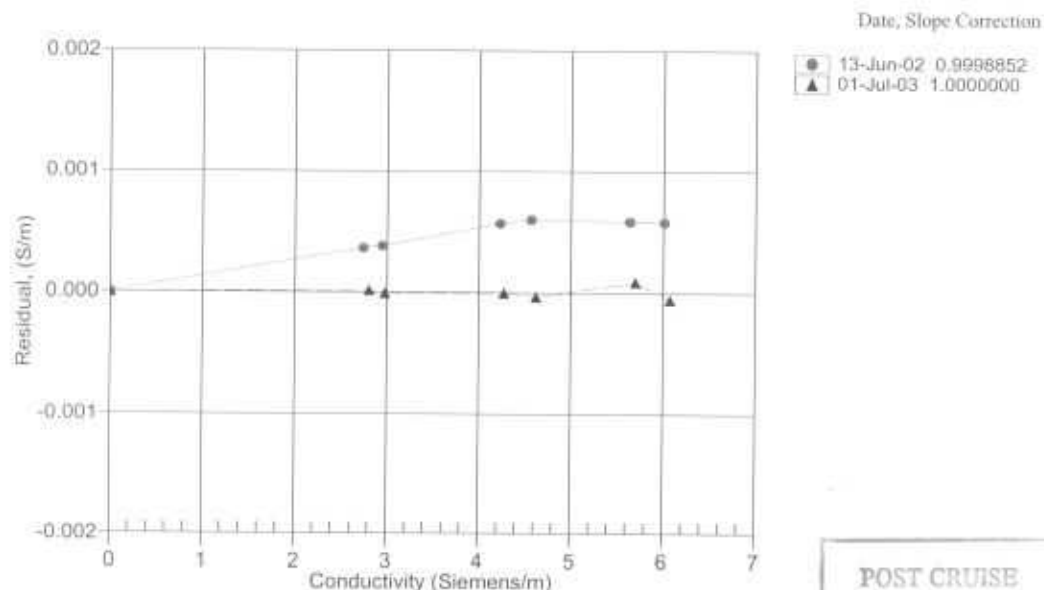
$a = 1.06053317e-006$
 $b = 5.09954471e-001$
 $c = -4.00267158e+000$
 $d = -8.69229210e-005$
 $m = 5.2$
 $CPCor = -9.5700e-008$ (nominal)

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	2.80158	0.00000	0.00000
-1.0003	34.7760	2.80161	7.91775	2.80162	0.00002
0.9997	34.7766	2.97287	8.12618	2.97286	-0.00001
14.9997	34.7771	4.26728	9.55156	4.26728	-0.00000
18.4997	34.7777	4.61377	9.90009	4.61374	-0.00003
28.9997	34.7755	5.69636	10.91054	5.69644	0.00009
32.4997	34.7703	6.06884	11.23644	6.06879	-0.00006

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

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

$$t = \text{temperature}[^{\circ}\text{C}]; p = \text{pressure[decibars]}; \delta = CTcor; \epsilon = CPcor;$$

$$\text{Residual} = (\text{instrument conductivity} - \text{bath conductivity}) \text{ using } g, h, i, j \text{ coefficients}$$


CTD Dissolved Oxygen**SEA-BIRD ELECTRONICS, INC.**

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

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

SENSOR SERIAL NUMBER: 0152

CALIBRATION DATE: 30-Jun-03w

SBE 43 OXYGEN CALIBRATION DATA

COEFFICIENTS

Soc = 0.5189

Boc = 0.0000

Voffset = -0.4986

TCor = 0.0016

PCor = 1.350e-04

BATH OX (ml/l)	BATH TEMP ITS-90	BATH SAL PSU	INSTRUMENT OUTPUT(VOLTS)	INSTRUMENT OXYGEN(ml/l)	RESIDUAL (ml/l)
1.66	25.00	0.03	1.033	1.66	0.00
1.92	5.00	0.04	0.909	1.92	0.00
2.48	25.00	0.03	1.296	2.48	0.00
2.79	5.00	0.04	1.094	2.78	-0.01
3.33	25.00	0.03	1.571	3.34	0.01
3.67	5.00	0.04	1.284	3.67	-0.00
5.10	25.00	0.03	2.134	5.09	-0.00
5.58	5.00	0.04	1.692	5.57	-0.00
6.92	25.00	0.03	2.719	6.91	-0.00
7.27	5.00	0.04	2.057	7.28	0.01

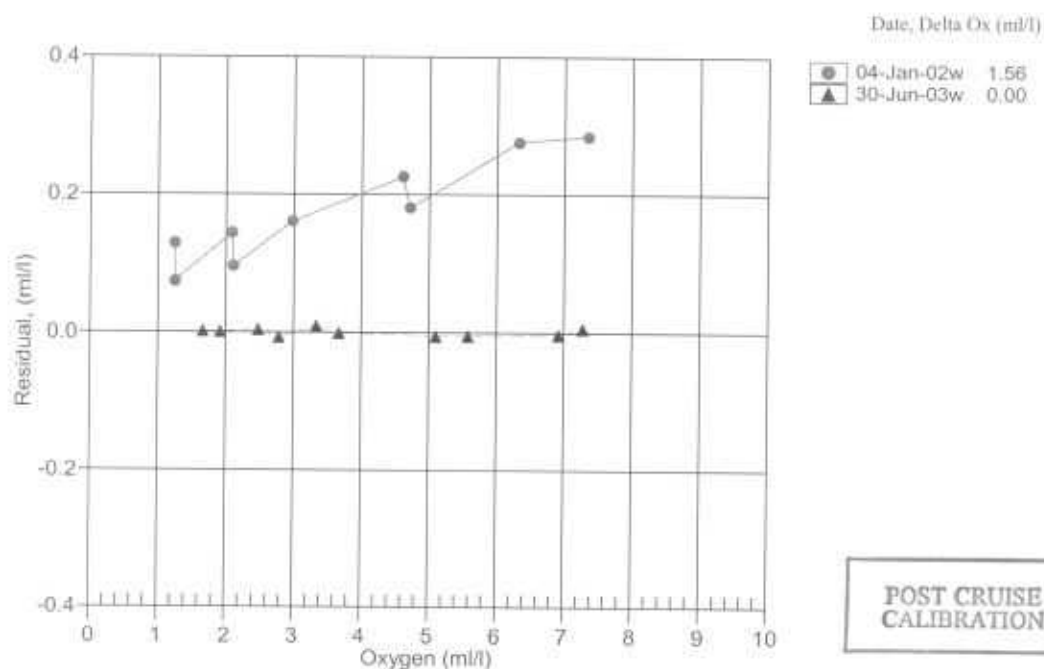
$$\text{oxygen (ml/l)} = (\text{Soc} * (\text{V} + \text{Voffset})) * \exp(\text{TCor} * \text{T}) * \text{Oxsat}(\text{T}, \text{S}) * \exp(\text{PCor} * \text{P})$$

V = voltage output from SBE43, T = ocean temperature [deg C]

S = ocean salinity [PSU] from CTD, P = ocean pressure [dbar] from CTD

Oxsat(T,S) = oxygen saturation [ml/l]

Residual = instrument oxygen - bath oxygen



CTD Transmissometer

Wetlabs C-Star Transmissometer
N.B. Palmer Onboard Calibration Sheet

Calibration Date: 10/14/03

Serial Number: CST- 439DR

Technician: Walter Gallager / Floyd Trujillo

Use the following table to enter voltages when performing an annual calibration of the instrument:

$Y_0 = V_d$	0.057	Voltage Blocked
$A_0 = V_{air}$	4.720	Voltage in air
$W_0 = V_{ref}$	4.616	Voltage in pure filtered H ₂ O from the Nanopure system.
Cal. Temp of Water	18.8	Temperature of the water during calibration. (Centigrade)
Ambient Temp	21.5	Air temperature during the calibration. (Centigrade)

The following equation is used by RVDas to obtain % of Transmittance:

$$\% \text{ Transmission} = 100\% * (V_{sig} - V_d) / (V_{ref} - V_d) \quad V_{sig} = \text{Signal Voltage at any point in time.}$$

Use the following table to enter measured voltages when putting the instrument in use:

Note: Use the system that the instrument is being installed in to measure the voltage.
 (i.e., CTD: Use the CTD Deck unit and read the voltage on the CTD Computer with the system on.)
Make sure the lenses are clean and dry!

Date:

Technician:

System:

	Value	Comments
$Y_1 = V_{dark} \text{ (current)}$		Current measured blocked voltage.
$A_1 = V_{air} \text{ (current)}$		Current measured voltage in air.
T_w	100%	%Transmission in pure water.

Use the following equations to obtain the M and B constants for Seasave for both the CTD and Thermosalinagraph:

(Select **Chelsea/Seatech/ Wetlabs C-Star** in **Seasave for Windows** or **Transmissometer** in **Seacon for DOS**).
 (Do NOT select Beam Transmissometer or WetLabs AC3)

$$M = (T_w / W_0) * (A_0 - Y_0) / (A_1 - Y_1) \quad B = -M Y_1$$

$$M = (100 / 4.735) * (4.893 - 0.057) / (\quad - \quad) \quad B =$$

$$M = \quad B =$$

$$\text{Path Length (M)} = 0.250$$

CTD Fluorometer

PO Box 518
620 Applegate St.
Philomath OR 97370



(541) 929-5650
Fax (541) 929-5277
<http://www.wetlabs.com>

Chlorophyll Fluorometer Characterization

Date: 7/21/03
Serial #: AFLT-009
Job#: 0009009
Tech: K.C

CWO (Vblank) 0.188 volts
CEV 2.73 volts
SF 9.8347

FSV 5.45 volts

Linearity: 0.999 R² (0–1.5 volts)
0.995 R² (0– 5.45 volts)

Notes:

CWO (Vblank) is the clean water offset value and is obtain using pure filtered de-ionized water.

CEV is the chlorophyll equivalent voltage. This value is the signal output of the fluorometer when using a fluorescent proxy that has been determined to be approximately equivalent to **25 µg/l** of a *Thalassiosira weissflogii* phytoplankton culture.

SF is the scale factor used to derive chlorophyll concentration from the signal voltage output of the fluorometer. The scale factor is determine by using the following equation:
 $SF = (25) / (CEV - CWO)$ e.g. $(25 / (2.865 - 0.238)) = 9.516$

FSV is the maximum signal voltage output that the fluorometer is capable of.

Chlorophyll concentration expressed in µg/l (mg/m³) can be derived by using the following equation: (µg/l) = (V_{measured} - CWO) * SF

The relationship between fluorescence and chlorophyll-*a* concentrations in-situ is high variable. The scale factor listed on this document was determined by 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 determination of chlorophyll concentration see [Standard Methods For The Examination Of Water And Wastewater] part 10200 H published jointly by: American Public Health Association, American Water Works Association and Water Environment Federation.

CTD PAR**Biospherical Instruments Inc**

CALIBRATION CERTIFICATE

UNDERWATER PAR SENSOR WITH LOG AMPLIFIER

Calibration Date: 10/24/03		Job No.: R8523							
Model Number: QSP200L									
Serial Number: 4361									
Operator: TPC									
Standard Lamp: 98700(5/19/01)									
Operating Voltage Range: 6 to 15 VDC (+)									
Note: The QSP-200L uses a log amplifier to measure the detector signal current with $V = \log I \text{ (Amps)} / I_{\text{Ref}}$ To calculate irradiance, use this formula:									
$\text{Irradiance} = \text{Calibration factor} * (10^{\text{Light Signal Voltage}} - 10^{\text{Dark Voltage}})$									
With the appropriate (solar corrected) Irradiance Calibration Factor:									
Dry Calibration Factor: 5.05E+12 quanta/cm ² sec/"amps"		8.39E-06 μEinsteins/cm ² sec/"amps"							
Wet Calibration Factor: 8.50E+12 quanta/cm ² sec/"amps"		1.41E-05 μEinsteins/cm ² sec/"amps"							
Sensor Test Data and Results⁴⁾									
Sensor Supply Current (Dark): 75.7 mA									
Supply Voltage: 6 Volts									
Lamp Integrated PAR Irradiance: 9.14E+15 quanta/cm ² sec		0.01518 μEinsteins/cm ² sec							
SC3 Immersion Coefficient: 0.594		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/cm ² sec)
No Filter	100.00%	3.258	100.00%	1.81E-07	1.81E-07	3.258	0.000	0.0	9.14E+15
0.3	36.10%	2.814	35.92%	6.51E-08	6.54E-08	2.816	0.002	0.5	3.28E+15
0.5	27.60%	2.701	27.66%	5.01E-08	5.00E-08	2.700	-0.001	-0.2	2.53E+15
1	9.27%	2.240	9.52%	1.72E-08	1.68E-08	2.229	-0.011	-2.6	8.70E+14
2	1.11%	1.351	1.16%	2.10E-09	2.01E-09	1.334	-0.017	-4.1	1.06E+14
3	0.05%	0.462	0.08%	1.43E-10	9.67E-11	0.387	-0.075	-32.3	7.21E+12
Dark Before: 0.168 Volts									
Light - No Filter Hldr.: 3.259 Volts				$I_{\text{Ref}} = 1.00E-10 \text{ Amps}$					
Dark After - NFH: 0.167 Volts				$I_{\text{Dark}} = 1.47E-10 \text{ Amps}$					
Average Dark 0.16725 Volts				$10^{V_{\text{Dark}}} = 1.469772 \text{ Amps}$					
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.xls

