Table of Contents

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 a DVD-R or CD-ROM written in ISO9660 level-1 format. It is readable by virtually every computing platform.

All the data has been compressed using Unix “gzip,” identified 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 important information that may affect the processing of this data.

Distribution Contents at a Glance

Volume 1

Directory	Files
/	0501data.doc
	cover.doc
	instcoef.txt
	NBP0501.trk
	NBP0501.mgd
	NBP0501.gmt
	trk0501.ps
	IVARS.tar
adcp/	adcp0501.tgz
images/	images.tar
ocean/ctd/	Process.tar
	Raw.tar
	SV.tar
ocean/xbt/	0501xbt.tar
process/	0501jgof.tar
	0501mgd.tar
	0501pco2
	0501proc
	0501qcps
	0501full.tar
	xrvdas.txt
scirep/	sci_rep.tar
rvdas/nav/	0501adcp.tar
	0501gp02.tar
	0501gyr.tar
	0501PCOD.tar
	0501seap.tar
	0501trax.tar
rvdas/uw/	0501flr.tar
	0501grv.tar
	0501knud.tar
	0501mbdp.tar
	0501met.tar
	0501pco2.tar
	0501pguv.tar
	0501sim.tar
	0501svp.tar
	0501tsg

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

Cruise Track

The distribution DVD includes a GMT cruise track file (NBP0501.trk). It contains the longitude and latitude at one-minute intervals extracted from the NBP0501.gmt file.

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, IdDDDYYA.jpg where:

Id = image type (ice = ice, wx = weather)
DDD = year-day
YY = year
A = allows for multiple images of one type for one day

Science Report

The weekly science reports are stored in the directory /scirep.

NBP Data Products

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

JGOFS

The JGOFS data set can be found on the distribution media in the file /process/0501jgof.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	μEinsteins/meter^2 sec
10	Sea surface temperature	°C
11	Sea surface conductivity	siemens/meter
12	Sea surface salinity	PSU

Field	Data	Units
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 NBP0501.mgd. Also at the root level, NBP0501.gmt is the output of the mgd77togmt utility using NBP0501.mgd as input. The NBP0501.gmt file can be used by GMT plotting software.

The data used to produce the NBP0501.mgd file can be found on the distribution media in the file /process/0501mgd.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)
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

Col	Len	Type	Contents	Description, Possible Values, Notes
				3 = Interpolated (Header Seq. 12) 9 = Unspecified
61-66	6	real	Magnetics total field, 1ST sensor	In tenths of nanoteslas (gammas)
67-72	6	real	Magnetics total field, 2ND 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 = 1st or leading sensor 2 = 2nd 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 10th of mgals. Corrected for Eotvos, drift, tares
98-103	6	real	EOTVOS correction	In 10th of mgals. E = 7.5 V cos phi sin alpha + 0.0042 V*V
104-108	5	real	Free-air anomaly	In 10th 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/0501adcp.tgz`. For more information on data format, visit http://currents.soest.hawaii.edu

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 `0501adcp.tar` in the directory `/rvdas/nav`.

pCO_2

The NBP carries Lamont-Doherty Earth Observatory's (LDEO) pCO_2 system and RPSC staff maintains it. Data is sent to LDEO at the end of each cruise. The pCO_2 data is transmitted and archived on RVDAS. You will find it in a file named `0501pco2.tar` in the /`process` directory, which contains the pCO_2 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 have been placed in three tar files in `/ocean/ctd: Process.tar Raw.tar` and `SV.tar` .

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 `0501xbt.tar` in the `/ocean/xbt` 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 tar archive `/process/0501full.tar`. 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: `NBP0107met1.d317`

- The CruiseID is the numeric name of the cruise, in this case, NBP0501.
- 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	Eppley PIR
PSP (SW radiation)	met1	Continuous	1 sec	Eppley PSP
PAR	met1	Continuous	1 sec	BSI QSR-240
GUV	guv	Continuous		BSI GUV-2511

Geophysics

Measurement	Channel ID	Collect. Status	Rate	Instrument
Gravimeter	grv1	Continuous	10 sec*	LaCoste & Romberg
Magnetometer	mag1	When possible	15 sec	EG&G G-877
Bathymetry	bat1	Not used	Varies	ODEC Bathy 2000
Bathymetry	knu1	Continuous	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
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.

<u>Underway Data</u>

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

*See page 18 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	yyyydddhhmmss	
4	Gravity count	mgal = count x 1.0046 + offset	count

Magnetometer (mag1)

```
05+031:22:51:10.559 =  63270.84  614   17.63
```

Field	Data	Units
1	RVDAS time tag	
2	= (field separator, part of output string)	
3	Magnetic field strength	nT
4	Signal strength	
5	Depth	meters

Bathy 2000 (bat1)

```
00+019:23:59:53.901 ;I04485.3ME -23.0, I00000.0,-99.9,0000@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	

Field	Data	Format / Possible Values	Units
13	Operating mode	MO1=CW parametric MO2=CW MO3=FM parametric MO4=FM	
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

Knudsen (knud)

```
99+099:00:18:19.775 HF,305.2,LF,304.3
```

Field	Data	Units
1	RVDAS time tag	
2	HF = High frequency flag (12 kHz)	
3	High frequency depth	meters
4	LF = Low frequency flag (3.5 kHz)	
5	Low frequency depth	meters

Simrad EM120 (mbdp)

05+039:00:00:15.846 $EMDPT,2865.72,0.0

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`

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 18 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	

pCO_2

```
00+021:23:59:43.190 2000021.9992 2382.4 984.2 30.73 50.8 345.9 334.1 -1.70
-68.046 -144.446 Equil
```

Field	Data	Units
1	RVDAS time tag	
2	pCO_2 time tag (decimal is fractional time of day)	yyyyddd.ttt
3	Raw voltage	mV
4	Barometer	mBar
5	Cell temperature	°C
6	Flow rate	ml/min
7	Concentration	ppm
8	pCO_2 pressure	microAtm
9	Equilibrated temperature	°C
10	Latitude (not collected)	
11	Longitude (not collected)	
12	Flow source (Equil = pCO_2 measurement)	

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	
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 $INVTG,19.96,T,,M,4.9,N,,K,A*39
```

Field	Data	Units
1	RVDAS time tag	
2	$GPVTG	
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	

Trimble (P-Code) GPS (PCOD)

The Trimble GPS, which formerly output Precise Position (*P-Code*) strings, but now only outputs Standard Position (*Civilian*) 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)	
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

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

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

Process

pCO2-merged

```
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
```

Field	Data	Units

Field	Data	Units
1	RVDAS time tag	
2	PCO_2 time tag (decimal is time of day)	yyyddd.ttt
3	Raw voltage	mV
4	Barometer	mB
5	Cell temperature	°C
6	Flow rate	cm^3/min
7	Concentration	ppm
8	PCO_2 pressure	microAtm
9	Equilibrated temperature	°C
10	Flow Source (Equil = pCO_2 measurement)	
11	RVDAS latitude	degrees
12	RVDAS longitude	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 `instcoef.txt` located in the / 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 instcoef.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 = $1/\{g + h[ln(f_0/f)] + i[ln^2(f_0/f)] + j[ln^3(f_0/f)]\} - 273.15$ (°C)

Calculating Conductivity – ITS-90

C = decimal equivalent of bytes 5-8
Conductivity Frequency f = sqrt(C*2100+6250000)
Conductivity = $(g + hf^2 + if^3 + jf^4)/[10(1 + \delta t + \varepsilon p)]$ (siemens/meter)
t = temperature (°C); p = pressure (decibars); δ = Ctcor; ε = CPcor

Calculating Fluorometry Voltage

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

Calculating Transmittance

V_{dark} = 0.058 V
V_{ref} = 4.765 V
t = decimal equivalent of bytes 18 – 20
Transmissometer Voltage (V_{signal}) = t/819
% Transmittance = $(V_{signal} - V_{dark}) / (V_{ref} - V_{dark})$

PAR

raw data = mV
calibration scale = 6.10 V/(μEinstiens/cm ^{2}sec)
offset (V_{dark}) = 0.3 mV
(*raw* mV - V_{dark})/scale x 10^4 cm^2/m^2 x 10^{-3} V/mV= μEinstiens/m^2sec
or
(*data* mV – 0.3 mV) x 1.65 (μEinstiens/m^2sec)/mV =
μEinstiens/m^2sec

PIR

raw data = mV

calibration scale = 4.13 x 10^{-6} V/(W/m^2)
data mV / (scale x 10^3 mV/V) = W/m^2
or
data mV x 242.1(W/m^2)/mV = W/m^2

PSP

raw data = mV
calibration scale = 8.05 x 10^{-6} V/(W/m^2)
data mV / (scale x 10^3 mV/V) = W/m^2
or
data mV x 120.7 (W/m^2)/V = 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.

Start	End	Description
028:07:35		Logging started for NBP0501
035		Trimble GPS down indefinitely
036:18:00		Most science mast (meteorological) instruments down due to short.
036:20:35		ET: repaired met instruments, except starboard anemometer.
044:00:00		End data collection.

Appendix: Sensors and Calibrations

NBP0501 Sensors:

Shipboard Sensors

Sensor	Description	Serial #	Last Calibration Date	Status
Meteorology & Radiometers				
Port Anemometer	RM Young 5106	WM51143	09/27/04	Collect
Stbd Anemometer	RM Young 5106	WM51144	09/27/04	Collect
Barometer	RM Young 61201	00872	05/13/04	Collect
Air Temp/Rel. Hum.	RM Young 41372LC	06733	08/07/04	
Mast PRR	BSI PRR-610			Not used
UW PRR	BSI PRR-600			Not used
PIR (Pyrgeometer)	Eppley PIR	32845F3	06/28/04	Collect
PSP (Pyranometer)	Eppley PSP	32850F3	06/22/04	Collect
Mast PAR	BSI QSR-240	6357	6/24/03	Collect
GUV	Ed0 GUV-2511	25110203114		Collect
PUV				Not used
Underway				
TSG	SeaBird SBE21	1390	06/30/04	Collect
TSG Remote Temp (primary)	SeaBird 3-01/S	2593	05/07/04	Collect
TSG Remote Temp (secondary)	SeaBird 3-01/S	4080	06/30/04	Collect
Fluorometer	Turner 10-AU-005 Lamp: daylight 10-045; ref. filter: 10-052, em. filter: 10-051, ex. filter: 10-050	5333-FRXX	N/A	Collect
Transmissometer*	WET Labs C-Star	CST-423PR	05/25/04	Collect
Transmissometer*	WET Labs C-Star	CST-422PR	06/15/04	Collect
Magnetometer	EG&G G-877			Used
Gravimeter	LaCoste & Romberg Gravity Meter			Collect
Bathymetry	Simrad EK500	3001	11/1/95	Collect
Bathymetry	Knudsen 320B/R			Collect
Bathymetry	Bathy 2000			Collect

NBP 05-01 CTD Sensors

Sensor	Description	Serial #	Last Calibration Date	Status
CTD Fish	SeaBird model SBE 9+	09P10716-0377	02/08/03	Collect
CTD Fish Pressure	Paroscientific Digiquartz model 410K-105	53980	02/08/03	Collect
CTD Deck Unit	SeaBird model SBE 11+	11P7536-0317		Collect
Primary Temperature Sensor	SeaBird model 3-02/F	1238	06/25/04	Collect
Secondary Temperature Sensor	SeaBird model 3-02/F	2168	06/25/04	Collect
Primary Conductivity Sensor	SeaBird model 4-02/0	1143	06/24/04	Collect
Secondary Conductivity Sensor	SeaBird model 4C	0926	06/25/04	Collect
Primary Dissolved Oxygen Sensor	SeaBird model 13-02-B	0161	05/04/04	Collect
Secondary Dissolved Oxygen Senson	SeaBird modem 13-02-B	0152	05/04/04	Collect
PAR Sensor	Biospherical Instruments QSP200L	4471	05/14/04	Collect
Transmissometer	WET Labs C-Star	CST-557DR	12/03/04	Collect
Fluorometer	WET Labs Chlorophyll Fluorometer	AFLT-009	06/01/04	Collect

Calibrations

The following pages are replicas of current calibration sheets for the sensors used during this cruise.

Gravity Tie

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: 1/25/2005
Location: McMurdo Station, Antarctica
Station: Thiel 2 Base Station
Latitude: 77 deg 50' 55.9068" S
Longitude: 166 deg 40' 45.9629" E
Elevation: 46.21 meters
Gravity: 982970.52

Reference Code Numbers

	Value	Time (GMT)
Ship's meter before gravity tie (Digital Gravity)	10624.7	04:21
Ship's meter after gravity tie (Digital Gravity)	10624.7	06:02
Average	10624.7	
Ship Gravimeter's Calibration Constant	1.0046	
Corrected ship's meter (Digital Gravity)	10673.6	

	Value	Time (GMT)
Ship's meter before gravity tie (serial, RVDAS)	10624.7	04:21
Ship's meter after gravity tie (serial, RVDAS)	10624.7	06:02
Average (for comparison check only)	10624.7	

Portable Gravimeter Correction Divisor 1.007937

Station	Value	Time (GMT)	Temp	Date	OBS mgal, averaged
Pier measurement 1	6545.21	04:07	53.5	January 25, 2005	
Pier measurement 2	6545.27	04:09	53.5	January 25, 2005	6493.71
Pier measurement 3	6545.28	04:11	53.5	January 25, 2005	
Average	6545.25				
Station measurement 1	6537.82	05:42	53.5	January 25, 2005	
Station measurement 2	6537.78	05:44	53.5	January 25, 2005	6486.32
Station measurement 3	6537.80	05:45	53.5	January 25, 2005	
Average	6537.80				
Pier measurement 4	6545.24	05:55	53.5	January 25, 2005	
Pier measurement 5	6545.20	05:56	53.5	January 25, 2005	6493.67
Pier measurement 6	6545.19	05:57	53.5	January 25, 2005	
Average	6545.21				

Gravity offset from last tie 972304.82
Drift since last tie -0.80

OBS Differences

Station to Pier (1, 2, & 3 averaged)	7.39
Station to Pier (4, 5, & 6 averaged)	7.35
Averaged Differences	7.37
Gravity at pier	982977.89
Elevation of pier above gravimeter, meters	-1.0
Earth differential gravity, mgal/meter	0.3
Gravity at ship's gravimeter	982977.59
Gravity Offset	972304.02

Comments

Gravity tie completed by B. Evers at Mcmurdo/Theil base station (inside building 149). The pier measurements were taken just across the bridge (on the solid land side) from the McMurdo Ice Pier. The ship was located at the ice pier (approximate distance from ship was 80 m).

CTD

Pressure Sensor

Rec'd 2/24/03 GBF

Pressure Calibration Check 18 February 2003

pressure sensor model: Digiquartz 410K-105
sensor serial number: 53980
installed in: CTD 09P7536-0328

This pressure calibration is a check of the 'test' sensor against a stable reference pressure sensor. The reference pressure sensor is itself checked several times per year against a NIST-traceable pressure standard maintained at Paroscientific, Inc.. The circumstances of this pressure check introduce no more than 1.5 psia total error in 10,000 psi (0.015 %) in addition to the error resident in the Paroscientific site standard. The check offers a very high level certification of the health and proper operation of the 'test' sensor.

Input Pressure* [psia]	Sensor Output [hz]	Sensor Temperature [deg C]	Pressure Factory Coef [psia]	Pressure Corrected [psia]	Error [psia]
14.739	33053.13	18.4	15.416	14.770	0.031
2014.807	33613.00	18.5	2015.792	2015.143	0.336
4015.169	34162.06	18.6	4015.928	4015.277	0.108
6015.370	34700.87	18.7	6015.956	6015.303	-0.067
8015.212	35229.94	18.7	8015.987	8015.332	0.120
10015.411	35749.65	18.8	10015.754	10015.097	-0.314
8015.408	35229.95	18.8	8016.019	8015.364	-0.044
6015.276	34700.91	18.8	6016.072	6015.419	0.143
4015.174	34162.11	18.9	4016.056	4015.405	0.231
2015.132	33613.02	18.9	2015.799	2015.151	0.019
14.729	33052.98	19.0	14.811	14.165	-0.564

Input pressure is generated with a Ruska model 5201 dead-weight tester, serial number 23330/380, and is determined by measurement with reference pressure sensor model Digiquartz 410K-105, serial number 73292.

Sensor Temperature: pressure sensor internal temperature.

Pressure Corrected: pressure computed with original factory coefficients and then corrected with a slope and offset to give the best linear agreement with the 'reference' Input pressure.

Error: Corrected pressure - Input pressure

A linear fit of this calibration data, between sensor pressure computed with factory coefficients and the Input pressure, yields correction coefficients:
Corrected pressure = psi slope * Factory pressure + psi offset [psia]
psi slope = 1.00000 and psi offset = -0.65 [psia]

These are converted to Slope and Offset for use in the SEASOFT programs by:
Slope = psi slope = 1.00000
Offset = 0.689476 * (psi offset - 14.7 * (1 - psi slope)) = -0.4455 [dbars]

Slope and Offset coefficients are entered into the pressure sensor calibration coefficient section of the <>.CON file using the program SEACON.

Digiquartz Coefficients:

C1 = -5.847002e+04
C2 = 6.910390e-01
C3 = 1.753360e-02
D1 = 4.241600e-02
D2 = 0.000000e+00
T1 = 3.026040e+01
T2 = -1.938830e-04
T3 = 4.330190e-06
T4 = 2.020250e-09

AD590 Pressure Temperature Coefficients:

AD590M = 0.01133
AD590B = -8.47592

Calibration Correction:

Slope = 1.00000
Offset = -0.4455

Primary Temperature Sensor

Primary Temp

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: 1238
CALIBRATION DATE: 25-Jun-04

SBE3 TEMPERATURE CALIBRATION DATA
ITS-90 TEMPRATURE SCALE

ITS-90 COEFFICIENTS
g = 4.82453028e-003
h = 6.70564150e-004
i = 2.56108898e-005
j = 2.04071535e-006
f0 = 1000.0

ITS-68 COEFFICIENTS
a = 3.68121176e-003
b = 5.97986278e-004
c = 1.45422716e-005
d = 2.04211181e-006
f0 = 6124.826

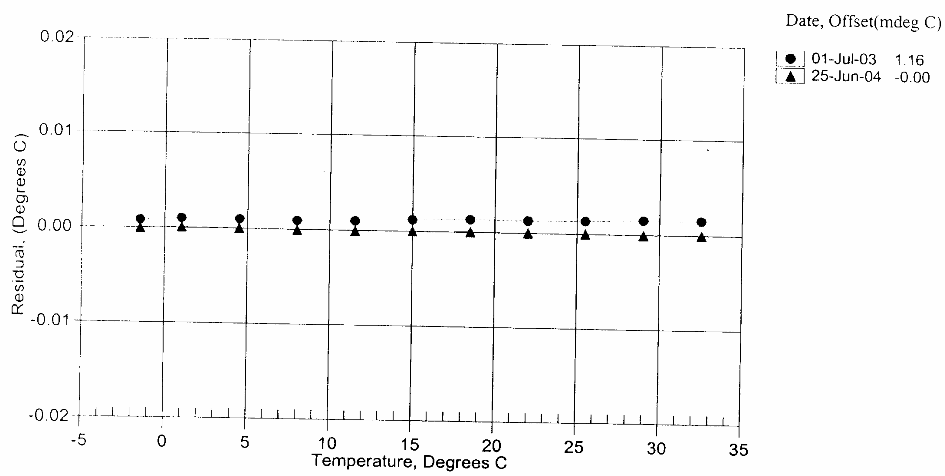
BATH TEMP (ITS-90)	INSTRUMENT FREQ (Hz)	INST TEMP (ITS-90)	RESIDUAL (ITS-90)
-1.4999	6124.826	-1.5000	-0.00006
1.0001	6479.094	1.0002	0.00009
4.5001	6999.508	4.5001	0.00002
8.0001	7549.198	8.0000	-0.00005
11.5001	8128.955	11.5000	-0.00005
15.0001	8739.533	15.0001	0.00001
18.5001	9381.642	18.5001	0.00004
22.0001	10055.982	22.0001	0.00001
25.5001	10763.247	25.5001	0.00001
29.0001	11504.072	29.0001	-0.00003
32.5001	12279.106	32.5001	0.00001

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

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

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

Residual = instrument temperature - bath temperature



Secondary Temperature Sensor

Secondary Temp

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: 2168
CALIBRATION DATE: 25-Jun-04

SBE3 TEMPERATURE CALIBRATION DATA
ITS-90 TEMPRATURE SCALE

ITS-90 COEFFICIENTS
g = 4.35077291e-003
h = 6.43696765e-004
i = 2.32911788e-005
j = 2.18555081e-006
f0 = 1000.0

ITS-68 COEFFICIENTS
a = 3.68121133e-003
b = 6.01246760e-004
c = 1.62507369e-005
d = 2.18710308e-006
f0 = 2938.746

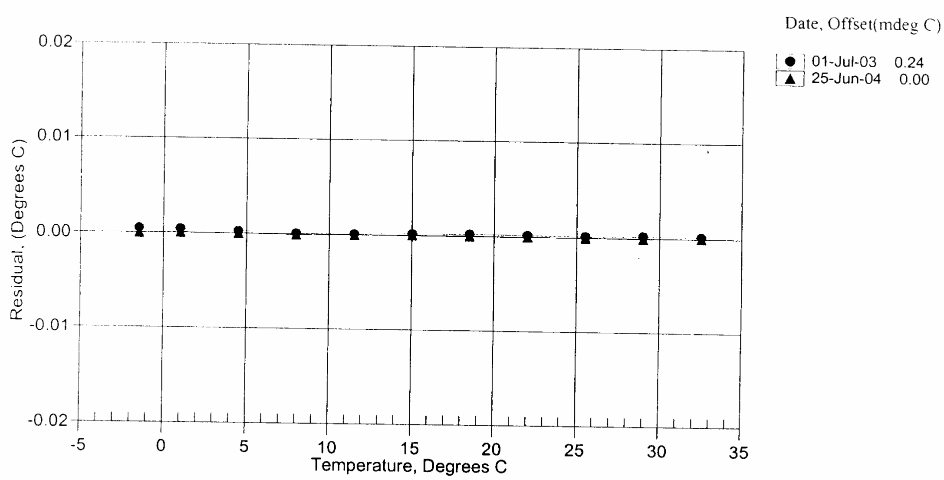
BATH TEMP (ITS-90)	INSTRUMENT FREQ (Hz)	INST TEMP (ITS-90)	RESIDUAL (ITS-90)
-1.4999	2938.746	-1.4999	-0.00003
1.0001	3107.799	1.0001	0.00005
4.5001	3356.145	4.5001	0.00002
8.0001	3618.466	8.0000	-0.00006
11.5001	3895.153	11.5001	-0.00002
15.0001	4186.565	15.0001	0.00002
18.5001	4493.057	18.5001	0.00004
22.0001	4814.972	22.0001	0.00001
25.5001	5152.646	25.5001	-0.00002
29.0001	5506.401	29.0001	-0.00004
32.5001	5876.553	32.5001	0.00003

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

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

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

Residual = instrument temperature - bath temperature



PAR

Biospherical PAR Model QSP-200L

Wet Calibration Factor in uEinsteins/cm2*sec/amps	5.73E-06
Average Dark (volts)	0.1965
Serial Number	4471.00
Calibration Date	May 14, 2004

PAR/Irradiance, Biospherical/Licor

Serial Number	4471
Calibration Date	14-May-2004
M	1
B	0
Calibration constant	17452006981
Multiplier	1
Offset	-0.09

OK Cancel

Transmissometer

Transmissometer, Chelsea/Seatech/Wetlab

Serial Number	CST-557DR
Calibration Date	12/3/2004
M	22.383
B	-1.231
Path length [m]	0.250

OK Cancel

Instructions: Fill out the Blue parts, print it out.
Fill out the SeaSave form so it looks like this.

From Calibration Sheet

Serial Number	CST-557DR
Cal Date:	Can't Read it
Vd	0.059
Vair	4.752
Vref	4.659
Pathlength (cm)	25

From On-CTD Pre-Cruise Measurements

Voltage in Air	4.613
Voltage Dark	0.055

Primary Conductivity Sensor

Primary Conductivity

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: 1143
CALIBRATION DATE: 24-Jun-04

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

GHIJ COEFFICIENTS

g = -4.17115686e+000
h = 5.32754693e-001
i = 1.61418691e-006
j = 2.87965436e-005
CPcor = -9.5700e-008 (nominal)
CTcor = 3.2500e-006 (nominal)

ABCDM COEFFICIENTS

a = 3.74460259e-005
b = 5.32652555e-001
c = -4.17045616e+000
d = -7.68771838e-005
m = 3.9
CPcor = -9.5700e-008 (nominal)

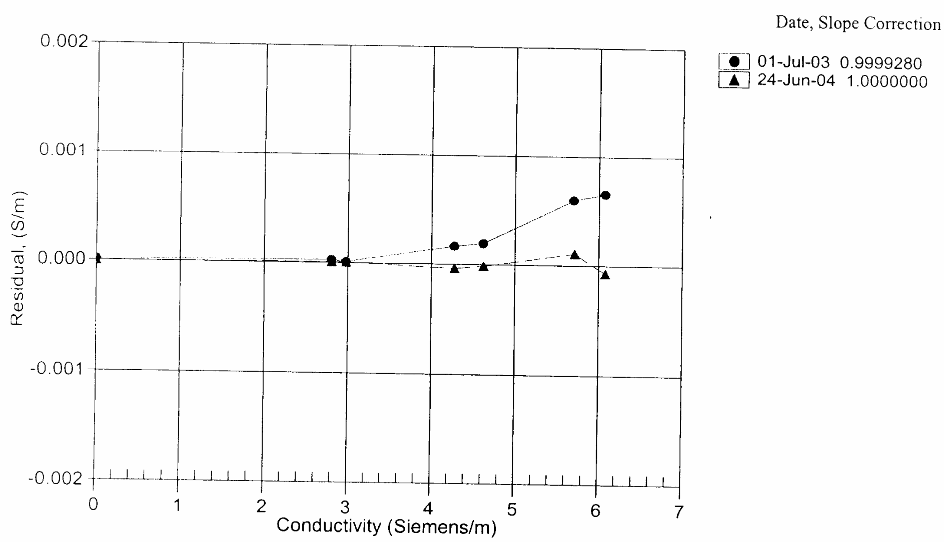
BATH TEMP (ITS-90)	BATH SAL (PSU)	BATH COND (Siemens/m)	INST FREQ (kHz)	INST COND (Siemens/m)	RESIDUAL (Siemens/m)
0.0000	0.0000	0.00000	2.79750	-0.00000	-0.00000
-1.0003	34.8499	2.80700	7.76659	2.80702	0.00001
0.9997	34.8501	2.97855	7.96986	2.97856	0.00001
14.9997	34.8512	4.27541	9.36300	4.27537	-0.00004
18.4997	34.8512	4.62247	9.70145	4.62245	-0.00001
28.9997	34.8494	5.70710	10.68908	5.70720	0.00011
32.4997	34.8451	6.08041	11.00790	6.08034	-0.00007

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

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

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

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



Secondary Conductivity Sensor

Secondary Conductivity

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: 0926
CALIBRATION DATE: 25-Jun-04

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

GHIJ COEFFICIENTS

g = -4.03404509e+000
h = 5.28109048e-001
i = -5.06007125e-004
j = 5.42314860e-005
CPcor = -9.5700e-008 (nominal)
CTcor = 3.2500e-006 (nominal)

ABCDM COEFFICIENTS

a = 2.49524615e-006
b = 5.26424796e-001
c = -4.02894389e+000
d = -9.90790841e-005
m = 4.9
CPcor = -9.5700e-008 (nominal)

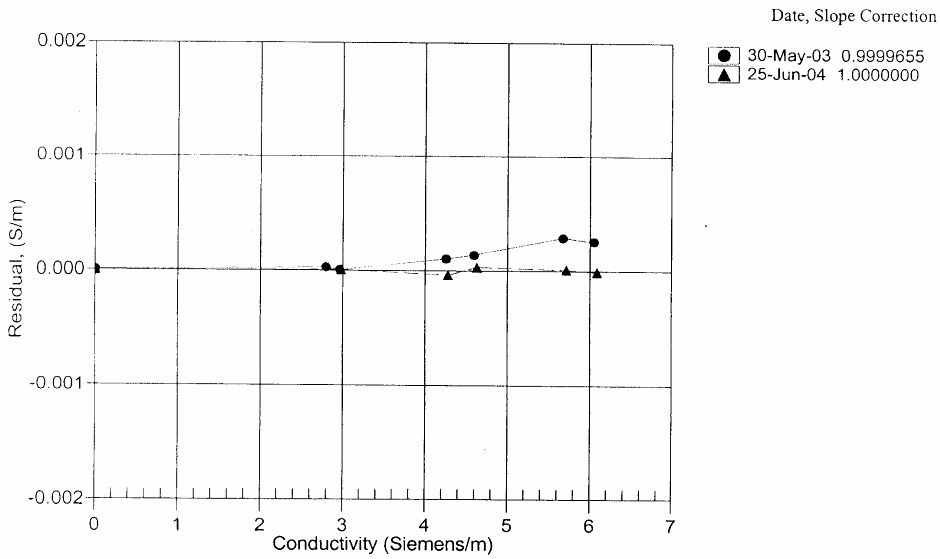
BATH TEMP (ITS-90)	BATH SAL (PSU)	BATH COND (Siemens/m)	INST FREQ (kHz)	INST COND (Siemens/m)	RESIDUAL (Siemens/m)
0.0000	0.0000	0.00000	2.76639	-0.00000	-0.00000
0.9997	34.8617	2.97945	8.00787	2.97946	0.00001
14.9997	34.8635	4.27676	9.41368	4.27672	-0.00004
18.4997	34.8634	4.62391	9.75500	4.62394	0.00003
28.9997	34.8620	5.70893	10.75031	5.70894	0.00001
32.4997	34.8557	6.08205	11.07134	6.08204	-0.00001

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

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

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

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



Meteorology System

Anemometer (Port)

RM Young Anemometer Calibration, Model 05106

S/N: 51143 **Date:** 19-Sep-04 **Cal'd By:** W. Gallagher

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	34.8	-0.5	66.6
8000	39.20	39.8	-0.6	76.2
9000	44.10	44.8	-0.7	85.7
10000	49.00	49.8	-0.8	95.2
12000	58.80	59.5	-0.7	114.2

Direction	Measured Direction	Delta Direction
0	0	0
30	28	2
60	58	2
90	88	2
120	118	2
150	148	2
180	179	1
210	210	0
240	240	0
270	270	0
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	2.4	0.0
1000	4.90	4.8	0.1
1500	7.35	7.4	-0.1
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	34.8	-0.5
8000	39.20	39.8	-0.6
9000	44.10	44.8	-0.7
10000	49.00	49.7	-0.7
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

Installed new housing assy and wind direction potentiometer coupling. Good calibration.

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: 51144 **Date:** 20-Sep-04 **Cal'd By:** W. Gallagher

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	1.0	0.0	1.9
500	2.45	2.3	0.2	4.8
1000	4.90	4.8	0.1	9.5
1500	7.35	7.3	0.0	14.3
2000	9.80	9.8	0.0	19.0
3000	14.70	14.7	0.0	28.6
4000	19.60	19.6	0.0	38.1
5000	24.50	24.6	-0.1	47.6
6000	29.40	29.4	0.0	57.1
7000	34.30	34.3	0.0	66.6
8000	39.20	39.2	0.0	76.2
9000	44.10	43.9	0.2	85.7
10000	49.00	48.7	0.3	95.2
12000	58.80	58.1	0.7	114.2

Direction	Measured Direction	Delta Direction
0	0	0
30	30	0
60	60	0
90	90	0
120	120	0
150	151	-1
180	182	-2
210	212	-2
240	242	-2
270	272	-2
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	0.0	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	14.6	0.1
4000	19.60	19.6	0.0
5000	24.50	24.5	0.0
6000	29.40	29.4	0.0
7000	34.30	34.3	0.0
8000	39.20	39.1	0.1
9000	44.10	43.8	0.3
10000	49.00	48.2	0.8
12000	58.80	57.7	1.1

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

Installed new housing assy. and wind direction coupling. Adjusted horizontal nose cone shaft. Good calibration.

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

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

EPLAB
Scientific Instruments for Precision Measurements Since 1917

STANDARDIZATION OF EPPLEY PRECISION INFRARED RADIOMETER Model PIR

Serial Number: 32845F3

Resistance: 738 Ω at 23 °C
Temperature Compensation Range: -20° to +40 °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 °C.

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

$$4.13 \times 10^{-6} \text{ volts/watts meter}^{-2}$$

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 ±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 28, 2004

In Charge of Test: R.T. Gessner

S.O. Number: 59900
Date: June 29, 2004

Reviewed by: Thomas Kirk

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: info@eppleylab.com Internet: www.eppleylab.com

EPLAB
Scientific Instruments for Precision Measurements Since 1917

STANDARDIZATION OF EPPLEY PRECISION SPECTRAL PYRANOMETER
Model PSP

Serial Number: 32850F3

Resistance: 706 Ω at 23 °C
Temperature Compensation Range: -20 to 40 °C

This radiometer has been compared with Standard Precision Spectral Pyranometer, Serial Number 21231F3 in Eppley's Integrating Hemisphere under radiation intensities of approximately 700 watts meter^{-2} (roughly one-half a solar constant). The adopted calibration temperature is 25 °C.

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

$$8.05 \times 10^{-6} \text{ volts/watts meter}^{-2}$$

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

The calibration of this instrument is traceable to standard self-calibrating cavity pyrheliometers in terms of the Systems Internationale des Unites (SI units), which participated in the 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/ft^{2}-hr^{-1} = 3.153 watts meter^{-2}

Shipped to:
Raytheon Polar Services Co.
Port Hueneme, CA

S.O. Number: 59901
Date: June 25, 2004

Remarks:

Date of Test: June 22, 2004

In Charge of Test: D. Gurley

Reviewed by: Thomas D Kirk

GUV

DASSN	DASdescription	DAStype	DASnavisionJob	Firmware	Tag	SystemSN
0069	Ed0	GUV-2511	R8785	005024HB v.0001 03-06-11	4	25110203114

ChannelDelay	Offset1	Offset16	Offset256	Gain1	Gain16	Gain256	Gain1to16
500	-0.00274658	9.5367E-05	0.00023365	-78	1259	-376	0.3125

Gain16to256	Gain16to1	Gain256to16	ResistorStoM	ResistorMtoL	ResistorMtoS	ResistorLtoM
0.01953125	0.546875	0.03417969	0.01953125	0.01953125	8.75	8.75

PAR

Installed 11/8/03 03:00 GMT

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:	6	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

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: 30-Jun-04

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

GHIJ COEFFICIENTS
g = -3.92735686e+000
h = 4.69593412e-001
i = 7.88574622e-004
j = -1.63254821e-005
CPcor = -9.5700e-008 (nominal)
CTcor = 3.2500e-006 (nominal)

ABCDM COEFFICIENTS
a = 1.50789233e-002
b = 4.51810364e-001
c = -3.91467271e+000
d = -9.50681789e-005
m = 2.2
CPcor = -9.5700e-008 (nominal)

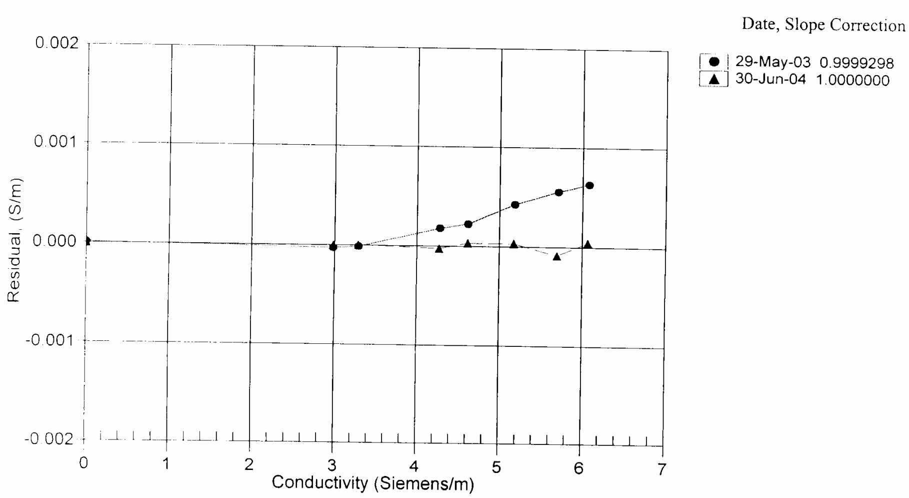
BATH TEMP (ITS-90)	BATH SAL (PSU)	BATH COND (Siemens/m)	INST FREQ (kHz)	INST COND (Siemens/m)	RESIDUAL (Siemens/m)
22.0000	0.0000	0.00000	2.88537	0.00000	0.00000
1.0000	34.8342	2.97735	8.42246	2.97735	-0.00000
4.4999	34.8136	3.28449	8.79618	3.28449	0.00000
14.9999	34.7694	4.26646	9.89584	4.26644	-0.00002
18.5000	34.7603	4.61174	10.25430	4.61177	0.00003
23.9999	34.7502	5.16987	10.80829	5.16990	0.00003
29.0000	34.7451	5.69197	11.30162	5.69188	-0.00008
32.5001	34.7431	6.06468	11.64108	6.06472	0.00004

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

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

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

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



Underway 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: 1390
CALIBRATION DATE: 30-Jun-04

SBE21 TEMPERATURE CALIBRATION DATA
ITS-90 TEMPRATURE SCALE

ITS-90 COEFFICIENTS
g = 4.21091217e-003
h = 5.96298114e-004
i = 5.75125605e-006
j = -1.525322850e-006
f0 = 1000.0

ITS-68 COEFFICIENTS
a = 3.64763618e-003
b = 5.81264971e-004
c = 1.01489249e-005
d = -1.52477478e-006
f0 = 2600.379

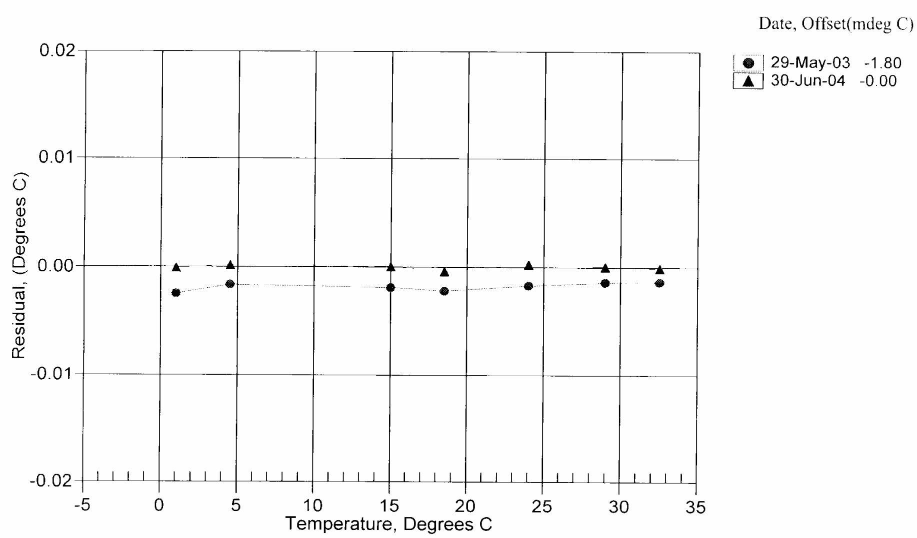
BATH TEMP (ITS-90)	INSTRUMENT FREQ (Hz)	INST TEMP (ITS-90)	RESIDUAL (ITS-90)
1.0000	2600.379	0.9999	-0.00009
4.4999	2814.813	4.5001	0.00016
14.9999	3533.674	15.0000	0.00006
18.5000	3799.742	18.4996	-0.00037
23.9999	4246.100	24.0002	0.00028
29.0000	4682.784	29.0001	0.00006
32.5001	5006.611	32.5000	-0.00010

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

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

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

Residual = instrument temperature - bath temperature



Underway Remote Temperature Sensor (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: 2593
CALIBRATION DATE: 07-May-04

SBE3 TEMPERATURE CALIBRATION DATA
ITS-90 TEMPRATURE SCALE

ITS-90 COEFFICIENTS
g = 4.27993207e-003
h = 6.19765239e-004
i = 2.07877574e-005
j = 1.64569178e-006
f0 = 1000.0

ITS-68 COEFFICIENTS
a = 3.68121249e-003
b = 5.83371574e-004
c = 1.58928225e-005
d = 1.64710620e-006
f0 = 2709.446

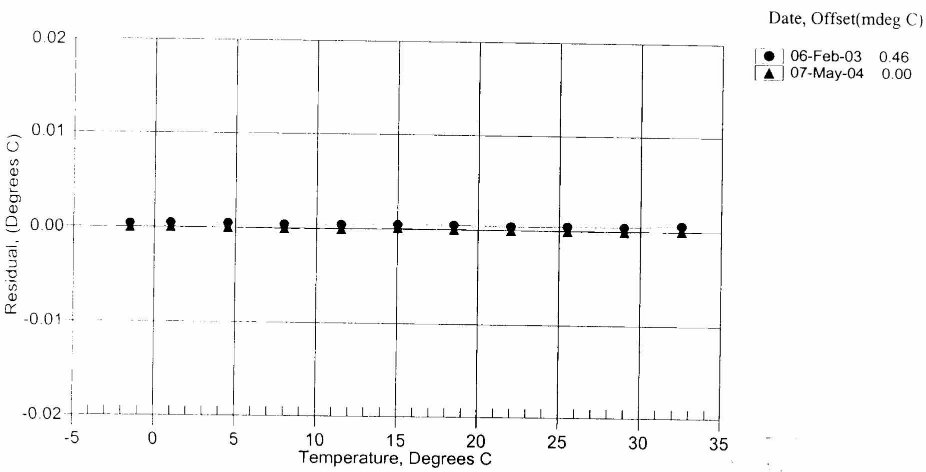
BATH TEMP (ITS-90)	INSTRUMENT FREQ (Hz)	INST TEMP (ITS-90)	RESIDUAL (ITS-90)
-1.5000	2709.446	-1.5000	-0.00001
1.0000	2870.232	1.0000	0.00004
4.5000	3106.957	4.5000	-0.00000
8.0000	3357.645	7.9999	-0.00007
11.5000	3622.733	11.5000	-0.00005
15.0000	3902.647	15.0001	0.00010
18.5000	4197.773	18.5000	0.00004
22.0000	4508.534	22.0000	-0.00000
25.5000	4835.324	25.5000	-0.00004
29.0000	5178.530	28.9999	-0.00007
32.5000	5538.541	32.5001	0.00006

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

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

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

Residual = instrument temperature - bath temperature



Underway Remote Temperature Sensor (secondary)

Secondary Remote Temp

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: 4080
CALIBRATION DATE: 30-Jun-04

SBE3 TEMPERATURE CALIBRATION DATA
ITS-90 TEMPRATURE SCALE

ITS-90 COEFFICIENTS

g = 4.38285805e-003
h = 6.44248089e-004
i = 2.18564722e-005
j = 1.64180015e-006
f0 = 1000.0

ITS-68 COEFFICIENTS

a = 3.68121203e-003
b = 6.01331473e-004
c = 1.63249716e-005
d = 1.64328372e-006
f0 = 3091.489

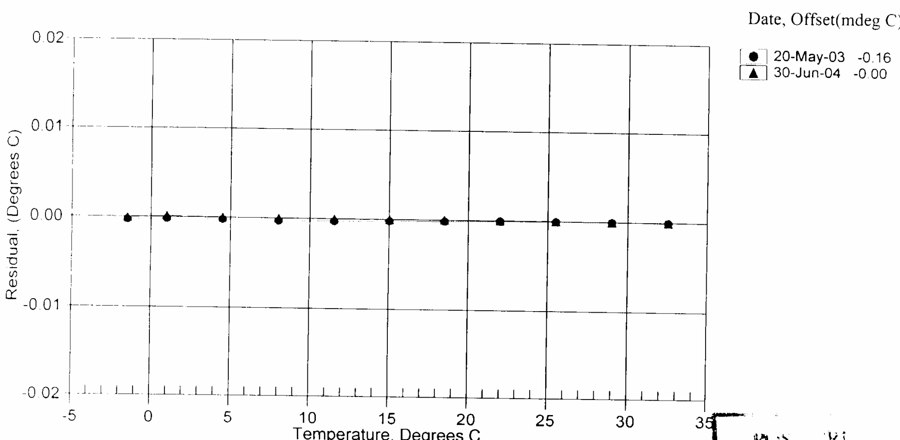
BATH TEMP (ITS-90)	INSTRUMENT FREQ (Hz)	INST TEMP (ITS-90)	RESIDUAL (ITS-90)
-1.4999	3091.489	-1.5000	-0.00008
1.0001	3269.313	1.0002	0.00011
4.5001	3530.536	4.5001	0.00002
8.0001	3806.484	8.0001	-0.00003
11.5001	4097.569	11.5001	-0.00003
15.0001	4404.188	15.0000	-0.00005
18.5001	4726.743	18.5001	0.00002
22.0001	5065.601	22.0001	0.00003
25.5001	5421.138	25.5001	0.00003
29.0001	5793.712	29.0001	0.00001
32.5001	6183.672	32.5001	-0.00003

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

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

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

Residual = instrument temperature - bath temperature



Underway Transmissometer (1)

PO Box 518
620 Applegate St.
Philomath, OR 97370

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

WET Labs

C-Star Calibration

Date 6/15/2004	Customer National Science Foundation	Work order 007
Job # 0012016	S/N# CST-422PR	Pathlength 25 cm

	Analog meter
V_d	0.061 V
V_{air}	4.786 V
V_{ref}	4.687 V

Temperature of calibration water	21.3 °C
Ambient temperature during calibration	22.5 °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.

cstarcalsheet Revision A 6/23/03

Underway Transmissometer (2)

PO Box 518
620 Applegate St.
Philomath, OR 97370

WET Labs

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

C-Star Calibration

Date 5/25/2004	Customer National Science Foundation	Work order 008
Job # 0012016	S/N# CST-423PR	Pathlength 25 cm

	Analog meter
V_d	0.059 V
V_{air}	4.807 V
V_{ref}	4.791 V

Temperature of calibration water	22.1 °C
Ambient temperature during calibration	22.4 °C

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

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

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

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.

cstarcalsheet Revision A 6/23/03

Appendix: IVARS

Stations

Station Number	Latitude	Longitude	Activities	CTD #
32	76° 54.57'S	171° 47.04'E	Productivity	01
33 (Calinectes)	77° 0'S	172° 48'E	Productivity, Camera	02, 03
34	77° 5.47'S	173° 48.88'E	Productivity	04
35	77° 11.22'S	174° 49.80'E	Standard	05
36	77° 16.57'S	175° 51.77'E	Productivity	06
37	77° 22.13'S	176° 54.02'E	Standard	07
38	77° 27.81'S	177° 55.99'E	Productivity	08
39	77° 33.80'S	178° 58.23'E	Standard	09
40 (Xiphias)	77° 40'S	180° 0'	Productivity, Camera	10, 11
41	77° 45.96'S	178° 56.23'W	Standard	12
42	77° 51.92'S	177° 52.66'W	Productivity	13?
43	77° 21.92'S	177° 52.66'W	Productivity	14
44	77° 15.96'S	178° 56.23'W	Standard	15
45	77° 10'S	180° 0'	Productivity	16
46	77° 3.80'S	178° 58.23'E	Standard	17
47	76° 57.81'S	177° 55.99'E	Productivity	18
48	76° 52.13'S	176° 54.02'E	Standard	19
49	76° 4 6.57'S	175° 51.77'E	Productivity	20
50	76° 41.22'S	174° 49.80'E	Standard	21
51	76° 35.47'S	173° 48.88'E	Productivity	22
52	76° 30'S	172° 48'E	Standard	23
53	76° 24.57'S	171° 47.04'E	Standard	24

Map of Stations