Data Report

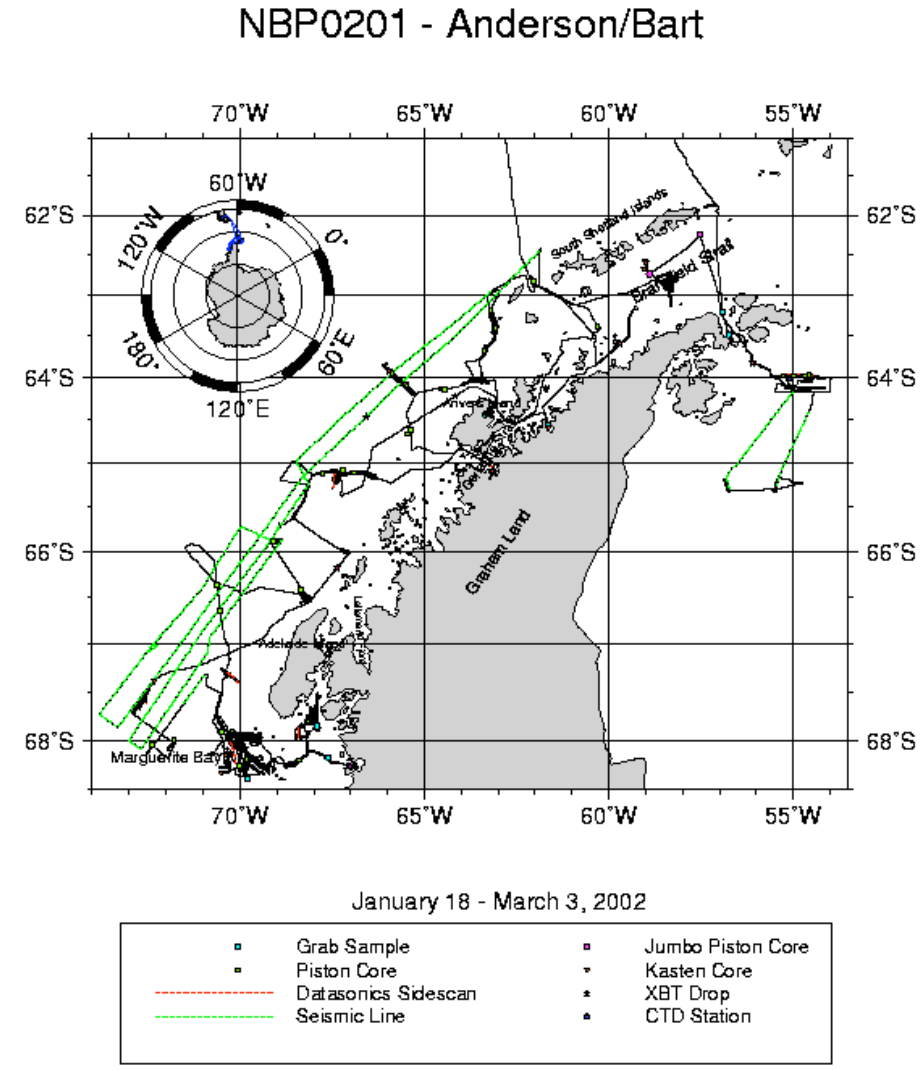

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Table of Contents

Introduction

The NBP data acquisition system continuously logs 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 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,” 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.

SeaBeam and bathyw data, if collected, is 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

geopdata/ 0201jgof.tar
0201proc.tar
0201qcps.tar
0201dpth.txt
NBP0201.trk
NBP0201.mgd
NBP0201.gmt
ocean/ 0201ctd.tar
0201pco2.tar
0201tsgp.tar
0201xbt.tar
plots/ *Cruise Plots*
report/ *Data Report*
0201coef.txt
rvdas/uw/ 0201bat.tar
0201flr.tar
0201grv.tar
0201mag.tar
0201met.tar
0201pco2.tar
0201sim.tar
0201svp.tar
0201tsg.tar
utility/ WinZip

Volume 2

adcp/ *pingdata files*
config files
imagery/ *TeraScan satellite images*
rvdas/nav/02013df.tar
0201adcp.tar
0201gyr.tar
0201ngl1.tar
0201PCOD.tar

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

Report

This data report can be found on the CD in the /report directory. It is archived as a MS Word document, an html document and as a plain text file.

Cruise Track

The distribution CD includes a GMT cruise track file (NBP0201.trk). It contains the longitude and latitude at one-minute intervals extracted from the NBP0201.gmt file.

A poster-sized PostScript cruise-track/station plot has been produced and placed in the /plots directory and named 0201plot.ps. An 8.5" x 11" version of the cruise track plot is named 0201smll.ps

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 (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

NBP Data Products

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

JGOFS

The JGOFS data set consists of 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 by the NGL software package. During the cruise, the JGOFS data set produces the daily data plots. Note: Null, unused, or unknown fields are indicated as "NAN" 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	-

Field	Data	Units
07	Gyro Heading	Degrees (azimuth)
08	Course made good	Degrees (azimuth)
09	Mast PAR	Einsteins/meters^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 NBP0201.mgd. Also at the root level, NBP0201.gmt is the output of the mgd77togmt utility using NBP0201.mgd as input. The NBP0201.gmt file can be used by GMT plotting software.

The data used to produce the NBP0201.mgd file can be found on the distribution media in the file /geopdata/NBP0201proc.tar. The data files in the PROC directory of 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 directories in the archive contina interim processing files and are included to simplify possible reprocssing of the data using the RVDAS NBP processing scripts. The file 0201dpth.txt lists the sonar bathymetry source used for each day's processing.

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 "3" for data record
2-9	8	Char	Survey identifier	
10-14	5	int	Time zone correction	In hundredths of hours. Corrects time (in characters 13-27) to GMT when added; 0 = GMT
15-16	2	int	Year	2 digit year
17-18	2	int	Month	2 digit month
19-20	2	int	Day	
21-22	2	int	Hour	
23-27	5	real	Minutes x 1000	
28-35	8	real	Latitude x 100000	+ = North - = South. (–9000000 to 9000000)

Col	Len	Type	Contents	Description, Possible Values, Notes
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 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 tenths of mgals. E = 7.5 V cos phi sin alpha + 0.0042 V*V
104-108	5	real	Free-air anomaly	In tenths of milligals 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 in the directory /adcp. Each file represents 24 hours 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 `0201adcp.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 `0201pco2.tar` in the `ocean/` 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) for additional information.

Cruise Science

CTD

The ctd data have been placed in the tar file `ocean/0201ctd.tar`. The archive contains folders of processed data and raw data.

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 SeaBeam system. The data files from these launches are included as 0201`xbt.tar` in the `/ocean` directory.

RVDAS

The Research Vessel Data Acquisition System (RVDAS) was developed at the Lamont-Doherty Earth Observatory of Columbia University and has been in use on its research ship for several years. It has been 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, /ocean. 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, NBP0201.
- The Channel ID 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		not collected		BSI PUV-511
PUV		not collected		BSI PUV-500

Geophysics

Measurement	Channel ID	Collect. Status	Rate	Instrument
Gravimeter	grv1	continuous	10 sec*	LaCoste & Romberg
Magnetometer	mag1	collected	15 sec	EG&G G-866
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		continuous	6 sec	Calc. from pri. temp
Sea Surface Temp	tsg1	continuous	6 sec	SeaBird 3-01/S

Measurement	Channel ID	Collect. Status	Rate	Instrument
Fluorometry	flr1	continuous	1 sec	Turner 10-AU-005
Fluorometry	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	3df1	continuous	1 sec	Ashtech ADU2
P-Code GPS	PCOD	continuous	1 sec	Trimble 20636-00SM
Gyro	gyr1	Continuous	0.2 sec	Yokogawa Gyro
NGL	ngl1	Continuous	1 sec	NGL Processed Data

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

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

Field	Data	Units
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 17 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 1.0047 + offset	count

Magnetometer (mag1)

```
99+099:00:00:23.203 %  0  98 235928    0?372453
```

Field	Data	Units
1	RVDAS time tag	
2	% 0 denotes G-866 magnetometer	
3	Year-day	
4	Time	
5	0? Denotes high noise condition	
6	Magnetic data (last digit is 10^{th}'s place)	nT

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 F=[V=valid I=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	

Field	Data	Format / Possible Values	Units
		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	
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.	

Field	Data	Format / Possible Values	Units
		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 (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 17 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

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

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

Navigational Data

Ashtech GPS (3df1)

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

Field	Data	Units
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	

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)	

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	

Trimble P-Code GPS (PCOD)

The PCode GPS 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
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	

NGL System (ngl1)

```
00+019:23:59:59.857 -68.82822,-137.21416,1.10,279.27,251.10,0.00,0.00,0,
18.2587,1,1146973
```

Field	Data	Units
1	RVDAS time tag	
2	Latitude (south is negative)	degrees
3	Longitude (west is negative)	degrees
4	Ship speed	knots
5	Course made good	degrees
6	Gyro heading	degrees
7	PDOP	
8	HDOP	
9	Quality	
10	GPS up	
11	Fix Number	
12		

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	kn

Field	Data	Units
5	Ship Speed relative to reference layer, north vector	kn
6	Ship heading	degrees

Ocean

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
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	Siemens
5	Salinity	PSU
6	Fluorometry	V
7	Unused	

Calculations

The file 0201coef.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 = $1/\{g + h[ln(f_0/f)] + i[ln^2(f_0/f)] + j[ln^3(f_0/f)]\} - 273.15$ (°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

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 = 6.08 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 1.64 (μEinstiens/m^2sec)/mV = μEinstiens/m^2sec

PIR

raw data = mV

calibration scale = 3.88 x 10^{-6} V/(W/m^2)

data mV / (scale x 10^3 mV/V) = W/m^2
or
data mV x 257.7(W/m^2)/mV = W/m^2

PSP

raw data = mV
calibration scale = 8.19 x 10^{-6} V/(W/m^2)
data mV / (scale x 10^3 mV/V) = W/m^2
or
data mV x 122.1 (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 yy+ddd:hh:mm (yy is 2-digit year, ddd is year-day, hh is hour, and mm is minute). Times are reported in GMT.

Start	End	Description
02+018:15:31		Start of NBP0201 Data Collection under Chilean Permit
02+019:03:07		End Chilean Data Permit, Begin Argentine Data Permit
02+020:13:28		Cross out of Argentine 200 mi EEZ Limit
02+021:14:12	02+021:14:20	RVDAS terminal crashed, SeaBeam data collection interrupted
02+022:19:15		fluorometer cell cleaned
02+033:23:58		end collection of P-Code quality GPS on Trimble
02+033:23:58	02+034:02:06	no GPS collected by Trimble until it is switched to C/A-Code quality
02+037:19:30	02+037:21:15	replace fans on PSP and PIR
02+041:19:51	02+042:04:50	sonars disabled while at Palmer Station
02+043:09:12	02+043:11:15	underway water sampling system shutdown due to failure of plumbing
02+060:07:47	02+061:10:10	Towing Magnetometer
02+060:11:50		Crossed into Argentine EEZ data collection under permit
02+061:21:51		End Argentine Data Permit, Begin Chilean Data Permit
02+062:17:43		End Data Collection

Sensors and Calibrations

NBP0201 Shipboard Sensors

Sensor	Description	Serial #	Calib. Date	Status
Meteorology & Radiometers				
Port Anemometer	RM Young 5106	WM45834	04/11/01	collect
Stbd Anemometer	RM Young 5106	WM46263	04/11/01	collect
Barometer	RM Young 61201	01705	06/01/01	collect
Air Temp/Rel. Hum.	RM Young 41372LC	06134	06/01/01	
Mast PRR	BSI PRR-610			Not used
UW PRR	BSI PRR-600			Not used
PIR (Pyrgeometer)	Eppley PIR	33023F3	12/07/01	collect
PSP (Pyranometer)	Eppley PSP	33090F3	12/06/01	collect
Mast PAR	BSI QSR-240	6356	02/15/01	collect
GUV				Not used
PUV				Not used
Underway				
TSG	SeaBird SBE21	2148857-0857	02/07/01	collect
TSG Remote Temp	SeaBird 3-01/S	031267	06/12/01	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	01/02/01	collect
Magnetometer	EG&G G-866			collect
Gravimeter	LaCoste & Romberg Gravity Meter			collect
Bathymetry	Simrad EK500			collect
Bathymetry	Knudsen 320B/R			Not used
Bathymetry	Bathy 2000			collect
Other				
P-Code GPS	Trimble 20636-00 (SM)	0220035116	Key expires 07/10/02	collect
Attitude GPS	Ashtech ADU2	700273F2114 FW 7B13-D1-C21	N/A	collect

NBP0201 CTD Sensors

Sensor	Description	Serial #	Calib. Date	Status
CTD Fish	SeaBird model SBE 9+	09P10716-0377	07/13/01	collect
CTD Fish Pressure	Paroscientific model 410K-105 pressure sensor	58949	07/13/01	collect
CTD Deck Unit	SeaBird model SBE 11+	11P7536-		collect

Sensor	Description	Serial #	Calib. Date	Status
		0317		
Temperature Sensor	SeaBird model 3-02/F	2308	02/13/01	Collect
Conductivity Sensor	SeaBird model 4-02/0	1852	02/13/01	Collect

Calibrations

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

CTD Pressure Sensor

Pressure Calibration Check 13 July 2001

pressure sensor model: Digiquartz 410K-105
sensor serial number: 58949
installed in: CTD 09P10716-0377

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]
14.700	33360.59	23.2	14.668	14.986	0.286
2014.689	34041.54	23.2	2014.473	2014.776	0.087
4014.348	34706.93	23.3	4014.163	4014.452	0.104
6013.814	35357.64	23.3	6013.643	6013.918	0.104
8013.175	35994.51	23.3	8013.027	8013.288	0.113
10012.889	36618.31	23.3	10012.365	10012.612	-0.277
8013.257	35994.54	23.3	8013.101	8013.362	0.105
6013.753	35357.61	23.3	6013.535	6013.811	0.058
4014.262	34706.87	23.4	4013.938	4014.227	-0.035
2014.600	34041.43	23.4	2014.097	2014.400	-0.200
14.670	33360.38	23.4	14.007	14.325	-0.345

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-000, 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 = 0.99999 and psi_offset = +0.32 [psia]

These are converted to Slope and Offset in decibars for use in the SEASOFT programs by: Slope = psi_slope = 0.99999
Offset = C * (psi_offset - 14.7 * (1 - psi_slope)) = +0.2188 [dbars]
C = 0.689476 [dbar/psi]

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

Digiquartz Coefficients:

C1 = -4.840395e+04
C2 = -2.017057e-03
C3 = 1.464810e-02
D1 = 3.990600e-02
D2 = 0.000000e+00
T1 = 2.998386e+01
T2 = -2.560542e-04
T3 = 3.869120e-06
T4 = 2.452640e-09

AD590 Pressure Temperature Coefficients:

AD590M = 0.01146
AD590B = -8.45734

Calibration Correction:

Slope = 0.99999
Offset = +0.2188

CTD Temperature Sensor

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

SENSOR SERIAL NUMBER = 2308
CALIBRATION DATE: 13-Feb-01s

TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

ITS-90 COEFFICIENTS

g = 4.34511387e-03
h = 6.44649603e-04
i = 2.32791524e-05
j = 2.17789379e-06
f_0 = 1000.000

IPTS-68 COEFFICIENTS

a = 3.67988438e-03
b = 6.02488784e-04
c = 1.63217829e-05
d = 2.17945242e-06
f_0 = 2912.686

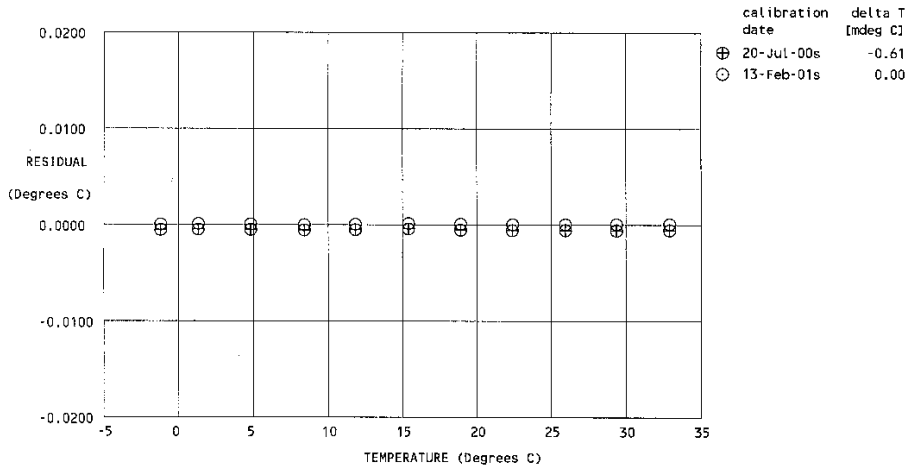
BATH TEMP (ITS-90 °C)	INSTRUMENT FREQ (Hz)	INST TEMP (ITS-90 °C)	RESIDUAL (ITS-90 °C)
-1.4020	2912.686	-1.4020	-0.00002
1.1064	3080.329	1.1064	0.00004
4.5997	3325.277	4.5997	0.00001
8.1974	3591.873	8.1973	-0.00007
11.6315	3860.289	11.6315	-0.00001
15.1885	4153.028	15.1886	0.00008
18.6926	4456.395	18.6926	0.00001
22.1918	4774.526	22.1918	-0.00003
25.7525	5114.166	25.7525	-0.00002
29.1672	5455.263	29.1672	-0.00001
32.7000	5824.319	32.7000	0.00002

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

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

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

Residual = instrument temperature - bath temperature



CTD Conductivity Sensor

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

SENSOR SERIAL NUMBER = 1852
CALIBRATION DATE: 13-Feb-01s

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

GHIJ COEFFICIENTS

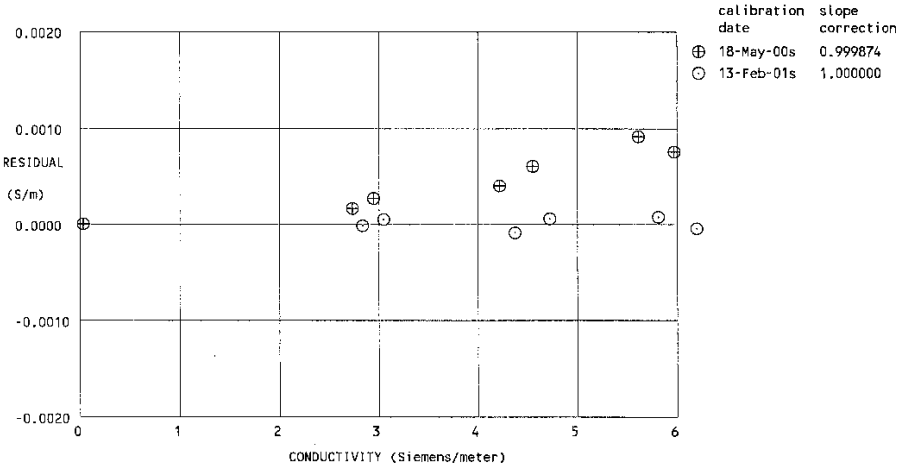
```
g = -4.01117657e+00
h =  5.12546273e-01
i = -6.99560953e-04
j =  6.25815267e-05
CPcor = -9.57e-08 (nominal)
CTcor = 3.25e-06 (nominal)
```

ABCDM COEFFICIENTS

```
a =  8.39979738e-07
b =  5.10029980e-01
c = -4.00275995e+00
d = -7.97220076e-05
m =  5.3
CPcor = -9.57e-08 (nominal)
```

BATH TEMP (IPTS-68 °C)	BATH SAL (PSU)	BATH COND (Siemens/m)	INST FREQ (kHz)	INST COND (Siemens/m)	RESIDUAL (Siemens/m)
0.0000	0.0000	0.00000	2.80151	-0.00000	-0.00000
-1.4420	35.3110	2.80288	7.91886	2.80286	-0.00002
1.0175	35.3098	3.01560	8.17699	3.01565	0.00005
15.1713	35.3104	4.34237	9.62905	4.34227	-0.00010
18.6473	35.3086	4.69106	9.97512	4.69111	0.00005
29.0551	35.3072	5.77876	10.98252	5.77883	0.00007
32.6126	35.3025	6.16250	11.31576	6.16245	-0.00005

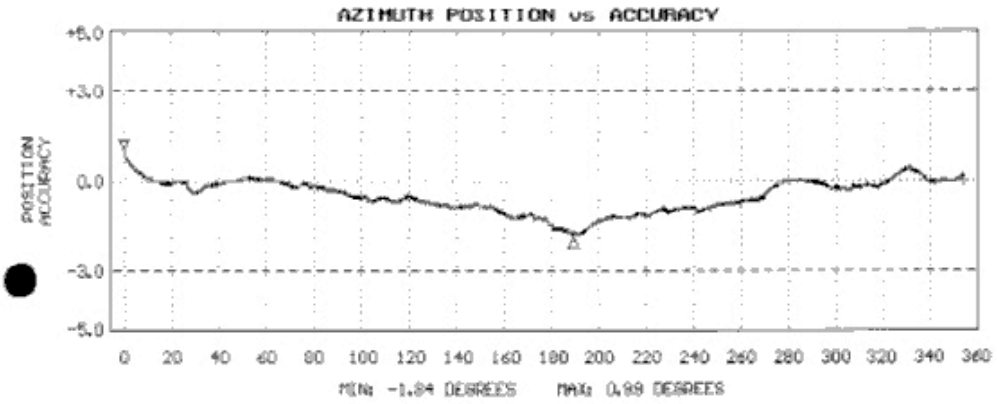
Conductivity = $(g + hf^2 + if^3 + jf^4) / [10(1 + \delta t + \epsilon p)]$ Siemens/meter
Conductivity = $(af^m + bf^2 + c + dt) / [10(1 + \epsilon p)]$ Siemens/meter
t = temperaure [deg C]; p = pressure [decibars]; δ = CTcor; ϵ = CPcor;
Residual = (instrument conductivity - bath conductivity) using g, h, i, j coefficients

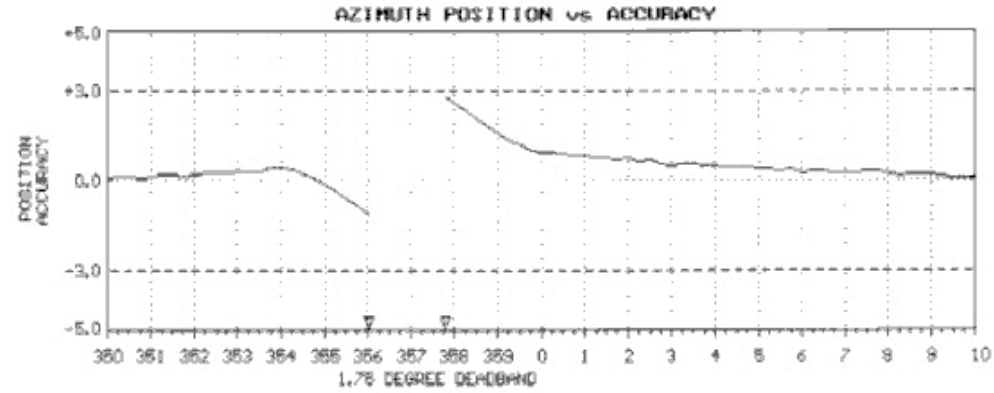


Anemometer (Port)

R. M. YOUNG COMPANY WIND SENSOR CALIBRATION CERTIFICATE

SENSOR: 05106 WIND MONITOR-MA
SENSOR SERIAL NUMBER: WM45834
BEARINGS: SEALED/WATERPROOF GREASE
DATE: APR 6 2001
WIND SPEED THRESHOLD TEST: PASS
LOW WIND SPEED AMPLITUDE/FREQUENCY TEST: PASS
HIGH WIND SPEED AMPLITUDE/FREQUENCY TEST: PASS
VANE TORQUE TEST: PASS
SPECIAL NOTES:
SPECIAL NOTES:



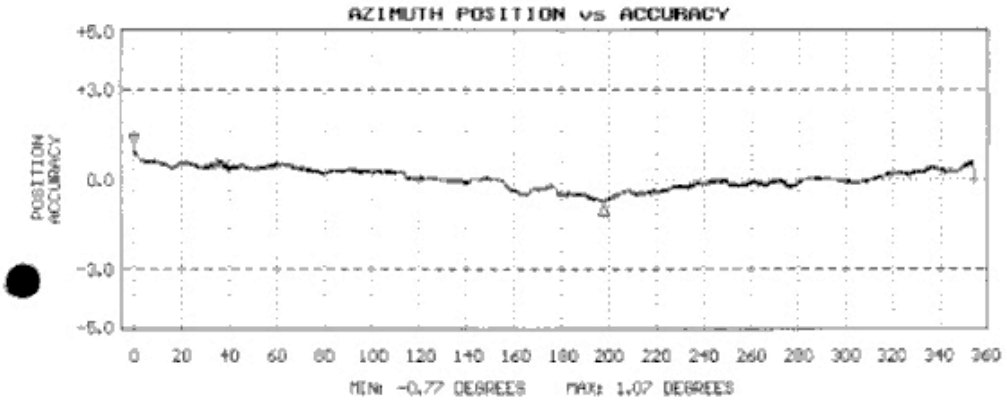


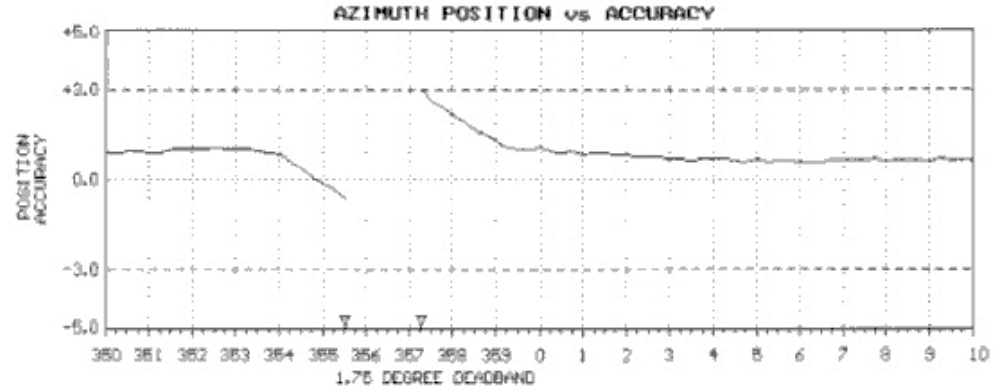
NOTE: Azimuth Position vs Accuracy graphs are accurate to within 0.5 degrees. The accuracy shown in the potentiometer deadband region between 355 and 0 degrees is the result of no resistance change while position changes. The gap represents the actual deadband (open circuit).

Anemometer (Starboard)

R. M. YOUNG COMPANY WIND SENSOR CALIBRATION CERTIFICATE

SENSOR: 05106 WIND MONITOR-MA
SENSOR SERIAL NUMBER: WM46263
BEARINGS: SEALED/WATERPROOF GREASE
DATE: APR 11 2001
WIND SPEED THRESHOLD TEST: PASS
LOW WIND SPEED AMPLITUDE/FREQUENCY TEST: PASS
HIGH WIND SPEED AMPLITUDE/FREQUENCY TEST: PASS
VANE TORQUE TEST: PASS
SPECIAL NOTES:
SPECIAL NOTES:





NOTE: Azimuth Position vs Accuracy graphs are accurate to within 0.5 degrees. The accuracy shown in the potentiometer deadband region between 355 and 0 degrees is the result of no resistance change while position changes. The gap represents the actual deadband (open circuit).

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: 33023F3

Resistance: 769 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:

$$3.88 \times 10^{-6} \text{ volts/watts meter}^{-2}$$

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:
National Science Foundation
Port Hueneme, CA

S.O. Number: 58775
Date: December 13, 2001

Date of Test: December 7, 2001

In Charge of Test: R. T. Forman

Reviewed by: Thomas D Kahl

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

EPLAB
Scientific Instruments for Precision Measurements Since 1917

STANDARDIZATION OF EPPLEY PRECISION SPECTRAL PYRANOMETER Model PSP

Serial Number: 33090F3

Resistance: 699 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:

8.19 x 10^{-6} volts/watts meter^{-2}

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

The calibration of this instrument is traceable to standard self-calibrating cavity pyrheliometers in terms of the Systems 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:
National Scientific Foundation
Port Hueneme, CA

S.O. Number: 58775
Date: December 13, 2001

Date of Test: December 6, 2001

In Charge of Test: R. T. Eppley

Reviewed by: Thomas D Kuhn

Remarks:

PAR

DO NOT DESTROY
Biospherical Instruments Inc.
CALIBRATION DATA

Biospherical Instruments Inc.

CALIBRATION CERTIFICATE

Calibration Date 2/15/01
Model Number QSR-240
Serial Number 6356
Operator TPC
Standard Lamp 94532(03/13/98)
Probe Excitation Voltage Range: 5 to 18 VDC(+)
Output Polarity: POSITIVE

Probe Conditions at Calibration(in air):

Calibration Voltage: 6 VDC(+)
Probe Current: 1.1 mA

Probe Output Voltage:

Probe Illuminated 86.6 mV
Probe Dark 0.3 mV
Probe Net Response 86.3 mV

Corrected Lamp Output:

Output In Air (same condition as calibration):

8.55E+15 quanta/cm²sec
0.014 uE/cm^{2}sec

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

Dry: 1.01E-17 V/(quanta/cm²sec)
6.08E+00 V/(uE/cm^{2}sec)

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

Underway Conductivity

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

SENSOR SERIAL NUMBER = 857
CALIBRATION DATE: 07-Feb-01

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

GHIJ COEFFICIENTS

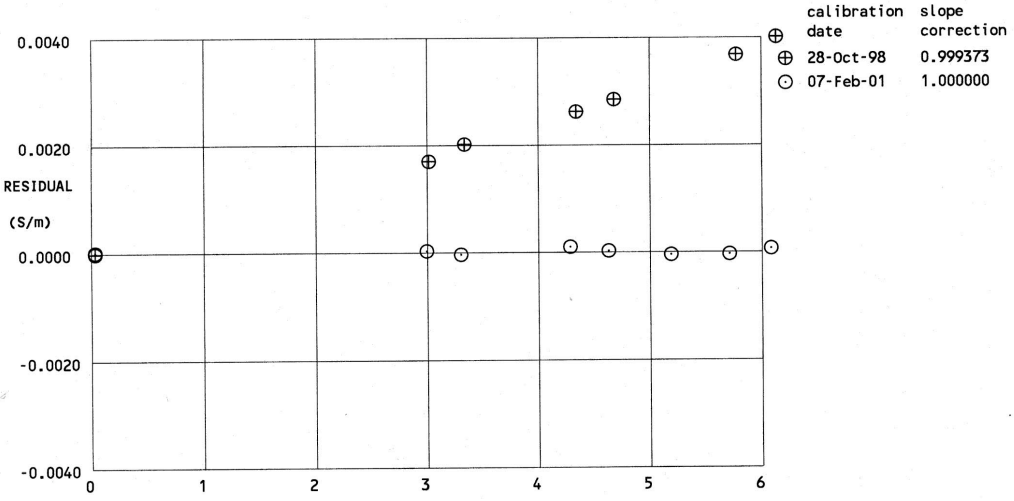
```
g = -4.05724357e+00
h =  4.84226382e-01
i =  1.14515552e-03
j = -2.84005419e-05
CPcor = -9.57e-08 (nominal)
CTcor = 3.25e-06 (nominal)
```

ABCDM COEFFICIENTS

```
a =  4.78926301e-02
b =  4.32368827e-01
c = -4.04137716e+00
d = -1.12306086e-04
m =  2.1
CPcor = -9.57e-08 (nominal)
```

BATH TEMP (ITS-90 °C)	BATH SAL (PSU)	BATH COND (Siemens/m)	INST FREQ (kHz)	INST COND (Siemens/m)	RESIDUAL (Siemens/m)
22.0000	0.0000	0.00000	2.88550	0.00000	0.00000
1.0001	34.6653	2.96429	8.27829	2.96430	0.00001
4.4999	34.6654	3.27188	8.64565	3.27183	-0.00005
14.9999	34.6641	4.25490	9.72645	4.25499	0.00009
18.5000	34.6631	4.60023	10.07823	4.60024	0.00001
24.0000	34.6604	5.15799	10.62162	5.15793	-0.00006
28.9999	34.6558	5.67898	11.10502	5.67893	-0.00005
32.4998	34.6481	6.04995	11.43675	6.05000	0.00005

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 = temperaure [deg C]; p = pressure [decibars]; δ = CTcor; ϵ = CPcor;
Residual = (instrument conductivity - bath conductivity) using g, h, i, j coefficients



POST CRUISE CALIBRATION

Underway Temperature Sensor

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

SENSOR SERIAL NUMBER = 857
CALIBRATION DATE: 07-Feb-01

TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

ITS-90 COEFFICIENTS

g = 4.24096327e-03
h = 5.99514049e-04
i = 4.88339043e-06
j = -1.67667318e-06
f_0 = 1000.000

IPTS-68 COEFFICIENTS

a = 3.64763319e-03
b = 5.84843916e-04
c = 9.94146384e-06
d = -1.67615257e-06
f_0 = 2720.016

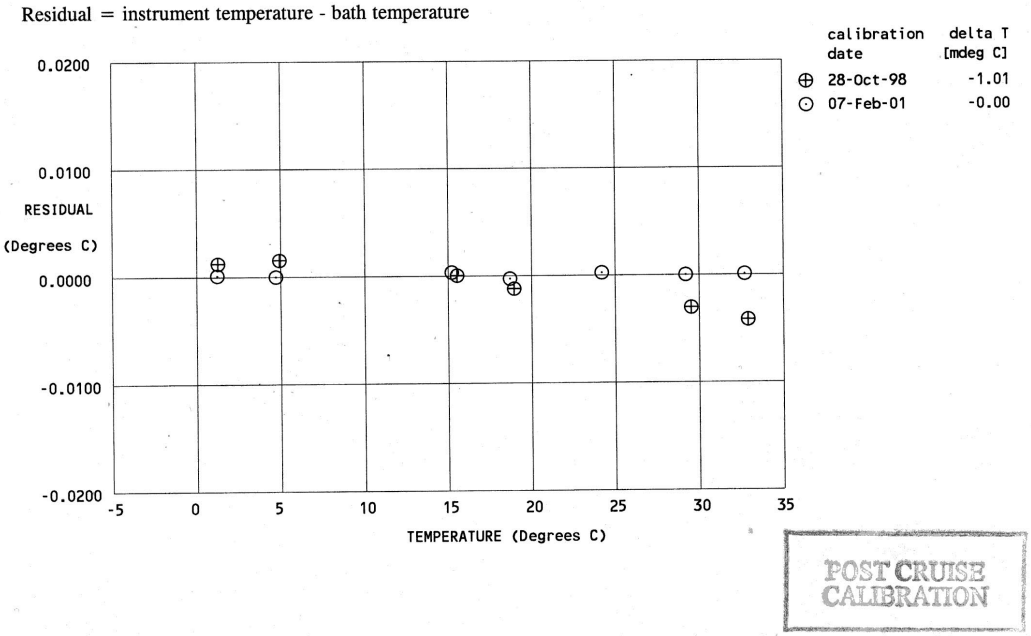
BATH TEMP (ITS-90 °C)	INSTRUMENT FREQ (Hz)	INST TEMP (ITS-90 °C)	RESIDUAL (ITS-90 °C)
1.0001	2720.016	1.0001	0.00003
4.4999	2942.848	4.4998	-0.00007
14.9999	3689.140	15.0002	0.00025
18.5000	3965.047	18.4997	-0.00033
24.0000	4427.621	24.0002	0.00016
28.9999	4879.819	28.9998	-0.00006
32.4998	5214.974	32.4998	0.00002

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

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



POST CRUISE CALIBRATION

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 Internet: seabird@seabird.com

SENSOR SERIAL NUMBER = [redacted]
CALIBRATION DATE: [redacted]

TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

ITS-90 COEFFICIENTS

g = 4.76637285e-03
h = 6.64703922e-04
i = 2.85244583e-05
j = 2.64328920e-06
f_0 = 1000.000

IPTS-68 COEFFICIENTS

a = 3.67984422e-03
b = 5.89471142e-04
c = 1.47206122e-05
d = 2.64476073e-06
f_0 = 5720.436

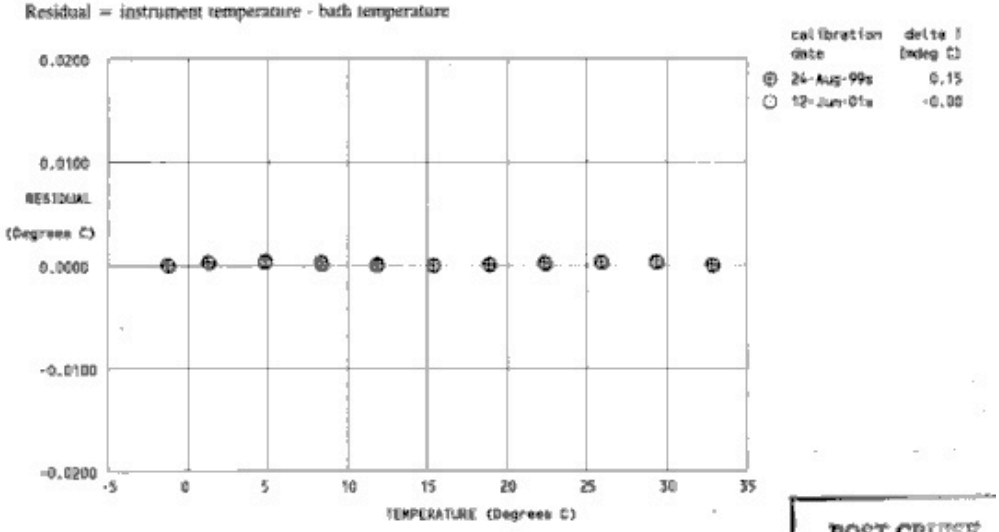
BATH TEMP (ITS-90 °C)	INSTRUMENT FREQ (Hz)	INST TEMP (ITS-90 °C)	RESIDUAL (ITS-90 °C)
-1.3989	5720.436	-1.3990	-0.00016
1.1096	6057.177	1.1098	0.00015
4.6023	6549.634	4.6024	0.00018
8.2003	7086.466	8.2003	-0.00001
11.6341	7627.516	11.6340	-0.00011
15.1913	8218.360	15.1911	-0.00015
18.6957	8831.382	18.6956	-0.00007
22.1954	9474.904	22.1954	0.00004
25.7553	10162.291	25.7555	0.00015
29.1723	10853.790	29.1725	0.00016
32.7057	11602.038	32.7055	-0.00018

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

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

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

Residual = instrument temperature - bath temperature



POST CRUISE CALIBRATION

Underway Transmissometer

C-Star Calibration Sheet

Date: [redacted]
Customer: National Science Foundation
Serial Number: [redacted]
Job Number: 0012016

V_d = V dark	0.059
V_{air} = V out in air	4.848
V_{ref} = V out in H_2O	4.818
Calibration Temp of H_2O	25.3
Ambient Temperature	25.1

% Transmission = $(V_{sig}-V_d)/(V_{ref}-V_d)$
$Tr = e^{-cx}$
To solve for the attenuation coefficient **c** in units of **m^{-1}** use the following equation.
$c = -1/x\ (\ln((V_{sig}-V_d)/(V_{ref}-V_d))$
For further information on these calculations please see C Star Users Guide section 1.

Temperature Error: 0.02% F.S./°C

NOTES
- **(V_d)** is the analog output of the instrument with the beam blocked. This is an instrumental offset.
- **(V_{air})** is the analog output voltage of the instrument with a cleared beam path.
- **(V_{ref})** is the analog output voltage of the instrument with clean H_2O in the path.
- **(Calibration Temp of H_2O)** is the temperature of the clean H_2O used to obtain **V_{ref}**.
- **(Ambient Temperature)** is the temperature of the instrument during the calibration procedures.
- **(V_{sig})** is the measured signal voltage of the C Star.

Gravity Tie

Date:	**1/17/02**			Reference Code Numbers:		
Location	**Punta Arenas, Chile**			Station no.	9337-50	
Station:	Harbour Admin. Bldg.			ISGN no.	51230N	
Latitude:	53 09 S					
Longitud	070 55 W					
Elevation						
Gravity:	981320.82					
		Value	**Time (GMT)**			
	Ship's meter before gravity tie (Digital Gravity)	8943.6	21:12			
	Ship's meter after gravity tie (Digital Gravity)	8945.3	22:07			
	Average	8944.5				
	Ship Gravimeter's Calibration Constant	1.0046				
	Corrected ship's meter (Digital Gravity)	8985.6				
		Value	**Time (GMT)**			
	Ship's meter before gravity tie (serial, RVDAS)	8984.7	21:10			
	Ship's meter after gravity tie (serial, RVDAS)	8984.5	22:08			
	Average (for comparison check only)	8984.6				
	Portable Gravimeter Correction Divisor	1.007937				
	Station	**Value**	**Time (GMT)**	**Temp**	**Date**	OBS mgal, averaged
	Pier measurement 1	4902.27	21:30	53.4	January 17, 2002	
	Pier measurement 2	4902.22	21:32	53.4	January 17, 2002	4863.62
	Pier measurement 3	4902.19	21:35	53.4	January 17, 2002	
	Average	4902.23				
						OBS
	Station measurement 1	4902.89	21:46	53.5	January 17, 2002	
	Station measurement 2	4902.85	21:48	53.5	January 17, 2002	4864.25
	Station measurement 3	4902.84	21:50	53.5	January 17, 2002	
	Average	4902.86				
						OBS
	Pier measurement 4	4902.37	22:02	53.5	January 17, 2002	
	Pier measurement 5	4902.37	22:03	53.5	January 17, 2002	4863.76
	Pier measurement 6	4902.35	22:05	53.5	January 17, 2002	
	Average	4902.36				
				Gravity offset from last tie		972334.0
				Drift since last tie		0.62
			Comments			
	OBS Differences		Gravity tie done by Romeo LaRiviere and Brent Evers			
	Station to Pier (1, 2, & 3 averaged)	-0.63				
	Station to Pier (4, 5, & 6 averaged)	-0.49				
	Averaged Differences	-0.56				
	Gravity at pier	981320.26				
	Elevation of pier above gravimeter, meters	0.0				
	Earth differential gravity, mgal/meter	0.3				
	Gravity at ship's gravimeter	981320.26				

	Gravity Offset	972334.66