

NBP0607C



End of Cruise Data Report

Created by: Chris Linden and Jim Dolan
Raytheon Polar Services Company
US Antarctic Program

Table of Contents

INTRODUCTION.....	1
ARCHIVE COMMANDS.....	1
DISTRIBUTION CONTENTS AT A GLANCE.....	2
VOLUME 1.....	2
DISTRIBUTION CONTENTS.....	3
CRUISE INFORMATION.....	3
<i>Cruise Track</i>	4
<i>Satellite Images</i>	4
<i>Science Reports</i>	4
NBP DATA PRODUCTS.....	4
<i>JGOFS</i>	4
<i>MGD77</i>	5
SCIENCE OF OPPORTUNITY.....	6
<i>ADCP</i>	6
<i>pCO₂</i>	7
CRUISE SCIENCE.....	7
XBT.....	7
RVDAS.....	7
<i>Sensors and Instruments</i>	7
Underway Sensors.....	8
Meteorology and Radiometry.....	8
Geophysics.....	8
Oceanography.....	8
Navigational Instruments.....	8
<i>Raw Data</i>	9
Underway Data.....	9
Sound Velocity Probe (svp1).....	9
Syntron Data (syn1).....	9
Oyo.....	9
Meteorology (met1).....	10
Gravimeter (grv1).....	10
Magnetometer (mag1).....	11
Bathy 2000 (bat1).....	11
Knudsen (knud).....	13
Simrad EM120 (mbdp).....	13
Simrad EK500 (sim1).....	13
Thermosalinograph (tsg1).....	14
Fluorometer (flr1).....	14
pCO ₂	14
Eng Das5 (eng1).....	14
Navigational Data.....	15
Seapath GPS (seap & sp2a).....	15
Trimble (P-Code) GPS (PCOD).....	17
Gyro Compass (gyr1).....	19
ADCP Course (adcp).....	19
Sound Velocity Probe (svp1).....	19
<i>Processed Data</i>	19
pCO ₂ -merged.....	19
tsgfl.....	20
CALCULATIONS.....	21
TSG.....	21
PAR.....	21
PSP.....	22

ACQUISITION PROBLEMS AND EVENTS	23
APPENDIX: SENSORS AND CALIBRATIONS.....	24
NBP0607C SENSORS:	24
<i>Shipboard Sensors</i>	24
CALIBRATIONS.....	24
GRAVITY TIE.....	25
METEOROLOGY SYSTEM.....	26
<i>Anemometer (Port)</i>	26
<i>Anemometer (Starboard)</i>	27
<i>PIR</i>	28
<i>PSP</i>	29
<i>GUV</i>	30
<i>PAR</i>	31
TSG CALIBRATION FILES	32
<i>Underway Conductivity</i>	32
<i>Underway Remote Temperature Sensor</i>	34
<i>Underway Transmissometer</i>	35

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

All data has been packaged in Unix tar archive files. Most files inside the tar archive have been compressed to reduce size. Compressed files are identified by the extension “gz”. Tools are available on all platforms for uncompressing and de-archiving these files:

On Macintosh, use Stuffit Expander with DropStuff or the command line utilities.

tar, gzip, and gunzip are standard tools on all Unix and Unix-like systems.

MultiBeam data is distributed separately.

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

Archive Commands

All archives were created using the command:

```
tar [z]cvf archive_name files_to_archive
```

With [z] being used to create “.tgz” archives.

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

```
tar [z]tvf archive_name > contents.list
```

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

To extract the files from the archive:

```
tar [z]xvf archive_name file(s)_to_extract
```


Distribution Contents at a Glance

Volume 1

NBP0607C.gmt
NBP0607C.mgd
NBP0607C.trk
0607CBE.gmt
INSTCOEF.TXT
NBP0607C.doc
NBP0607C.pdf
0607Ctrk.jpg
0607Ctrk.ps
NBP0607C.jpg
NBP0607C.ps
svp.tar

bathy2kw/
 607Cb2kw.tar

ocean/
 607Cctd.tar
 607Cxbt.tar

process/
 607CJGOF.tar
 607CMGD.tar
 607CPCO2.tar
 607CPROC.tar
 607CQC.tar

rvdas/nav/
 607Cadcp.tar
 607Cgyr1.tar
 607CPCOD.tar
 607Cseap.tar
 607Csp2a.tar

rvdas/uw/
 607Cbat1.tar
 607Cbird.tar
 607Ceng1.tar
 607Cflr1.tar
 607Cgrv1.tar
 607Cmag1.tar
 607Cmbdp.tar
 607Cmet1.tar
 607Coyol.tar
 607Cpco2.tar
 607Cpguv.tar
 607Csyn1.tar
 607Ctsg1.tar

images/
 isobar.tar
 wx.tar

Distribution Contents

Cruise Information

NBP0607C Research Objectives (*adapted from SIP*)

Cruise NBP0607C will test seismic reflection equipment and will host a marine geophysics class for undergraduate and graduate students. We will survey with gravity, magnetics, multibeam swath bathymetry, and echo sounder data whenever possible (so as not to interfere with the seismic equipment testing). The general survey area will be ENE of the Chatham Rise, New Zealand, inside of New Zealand waters. The primary research objective of studying this area is to determine the seafloor spreading history on both sides of the southernmost Wishbone Scarp, and test a recently proposed model that this region was an intra-oceanic subduction zone in Cretaceous time.

Field–Season Overview (*adapted from SIP*)

This cruise will be 14 days round trip out of Lyttelton, New Zealand. We will do about 2 days in transit to the east-northeast, to get into international waters. After that, we will do about 8 days of streamer testing and scientific cruise lines in international waters, followed by 3 days transit back to Lyttelton. We will have a party of approximately 23 people on board (3 professors, 20 students) for NBP06-07C. We will tow the magnetometer and collect swath bathymetry, Bathym2000 or Knudsen 320BR, and gravity data. We will be launching XBTs or XSVs about once per day, for control of the sound velocity profile of the water column. During the seismic streamer testing we will also use the GI guns, Bolt guns, streamer, birds, etc. We will deploy some sonobuoys during the seismic sea trials. We will need ET, IT, and Marine Tech support for deployment of the equipment, and use of the computer systems to collect, analyze, and archive the data. We will need IT people to produce the final data set. The IT people will also need to prepare the foreign data distribution for New Zealand. We will bring on board a laptop computer with seismic processing software for use by the class and as a dry run for the data collection and processing that will be done on a cruise later in the season (NBP0701). We will use the 03 lounge for 1 hour a day for a formal class in marine geophysics. The approximate location of the survey region, in international waters, will be in the area bounded by latitudes 40 S to 42 S and longitudes 168 W to 172 W.

Project Web Site

<http://www.gps.caltech.edu/~jstock/Palmerres.html>

Data Collection Report

Data collection began on julian day 282 @ 20:48 (GMT) as we left the harbor in Lyttelton NZ. Data collection ended on julian day 296 @ 02:50 (GMT), as the NBP approached port in Lyttelton, New Zealand.

A separate report for nearly all aspects of the seismic systems has been created for this cruise. Only those data recorded by the RVDAS system are described here. Please refer to the seismic report for any additional information concerning the seismic systems.

Since this was a Sea-trials cruise, continuous data collection was not a primary objective. Data was collected to the extent appropriate for the testing of the seismic systems. Gaps in data collection appear as result of testing; troubleshooting, and system deployment and recovery. This is particularly true of the magnetometer.

We experienced rough weather during some of the cruise. Problems with gravity data collection occurred on a few occasions when rough seas prevented the gravity meter from maintaining a proper level.

Cruise Track

The distribution DVD includes a GMT cruise track file (NBP0607C.trk). It contains the longitude and latitude at one-minute intervals extracted from the NBP0607C.gmt file.

A plot of the cruise track is available in postscript, and jpeg formats, in the files: NBP0607C.jpg, and NBP0607C.ps.

Satellite Images

Satellite, weather, and isobar images processed during this cruise can be found in the directory /images in two tar files: isobar.tar and wx.tar (weather).

Science Reports

A comprehensive science report for this cruise will be submitted to the Antarctic Multibeam Synthesis Data Portal. You may find it at <http://www.marine-geo.org/antarctic>.

NBP Data Products

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

The data processing scripts used to produce JGOFS and MGD77 data sets create a number of intermediate files. These files are included on the data distribution media in a file called 0607Cproc.tar. They are included to make re-processing easier in the event of an error, but no extensive detail of the formats is included in this document. For information, please contact itvessel@usap.gov.

JGOFS

The JGOFS data set may be found on the distribution media in the file /process/607CJGOF.tar. The archive contains one file produced for 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. Each daily file consists of 22 columnar fields in text format as described in the table below. The JGOFS data set is created from calibrated data decimated at one-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. Daily plots during the cruise are produced from the JGOFS data set. Note: Null, unused, or unknown fields are indicated as “NAN” or 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	$\mu\text{Einsteins/meter}^2 \text{ sec}$
10	Sea surface temperature	°C
11	Sea surface conductivity	siemens/meter

Field	Data	Units
12	Sea surface salinity	PSU
13	Sea depth (uncorrected, calc. sw sound vel. 1500 m/s)	meters
14	True wind speed (max speed windbird)	meters/sec
15	True wind direction (max speed 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 NBP0607C.mgd. The file NBP0607C.gmt is created from the MGD77 dataset using the “mgd77togmt” utility. NBP0607C.gmt can be used with the GMT plotting package.

The data used to produce the NBP0607C.mgd file can be found at the root of the distribution media and in the file /process/607CPROC.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.

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	This code details the procedure used for

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

Science of Opportunity

ADCP

The ADCP system measures currents in a depth range up to 1200 m (OS38 in deep profiling mode). In bad weather, ice, or unfavorable sea state the range is reduced, and sometimes no valid measurements are made. ADCP data collection is the OPP-funded project of Eric Firing (University of Hawaii) and Teri Chereskin (Scripps Institution of Oceanography). Data is collected on both the LMG and the NBP for the benefit of scientists on each cruise, and for the long-term goal of building a profile of current structure in the Southern Ocean.

A data feed is sent from the ADCP system to RVDAS whenever a reference layer is acquired. This feed contains east and north vectors for ship's speed, relative to the reference layer, and ship's heading. This data is saved in files located in `607Cadcp.tar` in the directory `/rvdas/nav`.

pCO₂

The NBP carries a pCO₂ measurement system from Lamont-Doherty Earth Observatory (LDEO). pCO₂ data is recorded by RVDAS and transmitted to LDEO at the end of each cruise. pCO₂ data is archived in the file `607Cpco2.tar` in the `/process` directory, which contains the pCO₂ instrument's data merged with GPS, meteorological and other oceanographic measurements. For more information contact Colm Sweeney (csweeney@ldeo.columbia.edu).

Cruise Science

XBT

During the cruise, eXpendable BathyThermographs were used to obtain water column temperature profiles. XBT profiles allow corrections to the sound velocity profile for the multi-beam system. The data files from these launches are included as `607Cxbt.tar` in the `/ocean` directory.

RVDAS

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

Daily data processing of the RVDAS data is performed to calibrate and 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 this data distribution. Quality-control plots for most instruments are created daily, and may be found in postscript format in the file `/process/607CQC.tar`. The tables below provide detailed information on the sensors and 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*. Raw data will be found on the distribution media as subdirectories under the top level `rvdas` directory: `/rvdas/uw`, and `/rvdas/nav`. 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: NBP0607Cmet1.d317

- The CruiseID is the numeric name of the cruise, in this case, NBP0607C.
- The ChannelID is a 4-character code representing the system being logged. For example the meteorology designation is "met1".
- 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 5106
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	2 sec	BSI PUV-2511
PUV	puv	Not Collected		BSI PUG-2500

Geophysics

Measurement	Channel ID	Collect. Status	Rate	Instrument
Gravimeter	grv1	Continuous	10 sec*	LaCoste & Romberg
Magnetometer	mag1	Per direction	1 sec	Sea Spy
Bathymetry	bat1	Per direction	Varies	ODEC Bathy 2000
Bathymetry	knu1	Not collected	Varies	Knudsen 320B/R
Bathymetry	sim1	Not collected	Varies	Simrad EK500 Sonar

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

Oceanography

Measurement	Channel ID	Collect. Status	Rate	Instrument
Conductivity	tsg1	Continuous	6 sec	SeaBird SBE-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
Trimble GPS	PCOD	Continuous	1 sec	Trimble 20636-00SM
Gyro	gyr1	Continuous	0.2 sec	Yokogawa Gyro
SeaPath	seap	Continuous	1 sec	SeaPath 200
SeaPath	sp2a	Continuous	1 sec	SeaPath 200

Raw Data

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

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

where

yy = two-digit year
 ddd = day of year
 hh = 2 digit hour of the day
 mm = 2 digit minute
 ss.sss = seconds

All times are reported in UTC.

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

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

Underway Data

Sound Velocity Probe (svp1)

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

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

Syntron Data (syn1)

```
00+120:10:46:30.665 *GCS 900228 005
811.00001E00/04/29:10:45:5311060600000000403000-0.050.023 00000000-
00101AP1N 000156498-0100002AP1N 00016350100100003AP1N 000162497-
0200004AP1N 00015850000000005AP1N 00015550100100006AP1N 000157500000000
```

Field	Data	Units
1	RVDAS time tag	
2	String tag	
3	Number of bytes	
4	Line number	
5	Shotpoint number	

Oyo

```
04+009:08:21:53.799 3388 31 49
```

Field	Data	Units
1	RVDAS Time Tag	
2	OYO Shot	
3	Reel	

Field	Data	Units
4	Channel	

Meteorology (met1)

01+322:00:03:27.306 04.5 292 010 05.7 294 010 0959.6 000.2 093.1

-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 (photo synthetically available radiation)*	mV

*See page 20 for calculations.

Gravimeter (grv1)

There are two sets of fields output by the gravity meter. The data record is output once per second, and identified by "\$DAT" in the id field. A summary of sensor environmental data is output every ten seconds, identified by "%ENV" in the id field.

Data record (\$DAT):

05+194:00:00:27.995 \$DAT,2005/ 7/13, 0: 7: 7.36,194, 9050.37, 9050.06, 5410.86, -0.00, -0.01, -0.02, 0.00, 0.00, 0.70, 0.19, -0.12, -0.25, 0.00, -69.45711315, -54.32181487, 0.000, 285.200,

Field	Data	Conversion	Units
1	RVDAS time tag		
2	Text string (id field)	\$DAT for data record	
3	Date	YYYY/MM/DD	
4	Time	HH:MM:SS.SS	
5	Day of Year	DDD	
6	Gravity count	mgal = count x 1.0046 + offset	count
7	Spring Tension		CU
8	Beam Position	Volts x 750,000	
9	VCC		
10	AL		
11	AX		
12	VE		
13	AX2		
14	XACC2		
15	LACC2		
16	CROSS ACCEL		GAL

Field	Data	Conversion	Units
17	LONG ACCEL		GAL
18	EOTVOS CORR		MGAL
19	LONGITUDE		Degrees
20	LATITUDE		Degrees
21	HEADING		Degrees
22	VELOCITY		Knots

Environmental record (\$ENV)

05+183:19:13:10.945 %ENV,2005/ 7/ 2,19:19:52.16,183,S-036/V1.5, 3.34,
 47.19, 20.34,1.111840E-1,-0.57700,-0.10591, 0.40180, 2.55260, 0.43000,
 1, 300

Field	Data	Conversion	Units
1	RVDAS time tag		
2	Text string (id field)	\$ENV for environmental record	
3	Date	YYYY/MM/DD	
4	Time	HH:MM:SS.SS	
5	Day of Year	DDD	
6	Meter ID		
7	Meter Pressure		inch-Hg
8	Meter temp		°C
9	Ambient temp		°C
10	K-Factor		
11	VCC Coeff		
12	AL Coeff		
13	AX Coeff		
14	VE Coeff		
15	AX2 Coeff		
16	Serial Filter Length		Seconds
17	QC Filter Length		Seconds

Magnetometer (mag1)

06+286:00:00:03.075 *06.286/00:00:03.0 F:055248.303 S:193 D:+037.8m L0
 0965ms Q:99

Field	Data	Units
1	RVDAS time tag	
2	Time	*YY.JJJ/HH:MM:SS.S
3	Magnetic Field	nT
4	Signal Strength (over 80 is acceptable)	3 digits
5	Towfish Depth	m
6	Leak Sensor (0 is no leak, 9 is leak present)	1 digit
7	Measurement time	ms
8	Signal quality (00-99)	2 digit

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	
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	

Field	Data	Format / Possible Values	Units
		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)

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

Field	Data	Units
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 21 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 (if temperature compensation package is installed)	
9	Temperature units (if temperature compensation package is installed)	

pCO2

00+021:23:59:43.190 2006114.02630 1960.80 20.64 1003.5 346.81 -1.63 341.7
52.49 0 13 Equil

Field	Data	Units
1	RVDAS time tag	
2	pCO ₂ time tag (decimal is fractional time of day)	yyyyddd.ttt
3	Raw voltage (IR)	mV
4	Cell temp (C)	°C
5	Barometric pressure (mbar)	MBar
6	CO ₂ conc. (ppm)	ppm
7	Equilibrator Temp (C)	°C
8	pCO ₂ pressure (uatm)	microAtm
9	Flow rate (cc/min)	ml / min
10	Valve Position (integer, note position 9 does not write, defaults to 1)	1 or 2 digits
11	Sample Code number (integer)	1 or 2 digits
12	Flow source (Equil = pCO ₂ measurement)	text

Eng Das5 (eng1)

06+284:01:17:03.259 111,2006,284,116,12.11,23.91,6.096,.14,127.4,-
 .432,.914,10.64,-6999,-6999,-6999

Field	Data	Units
1	RVDAS time tag	
2	Campbell code	3 digits
3	Year	yyyy
4	Julian day	jjj
5	Time GMT	hhmm
6	Power Supply Voltage	V
7	Internal Case Temperature	C
8	Pump #1 flow rate	L/min
9	Pump #1 flow rate	L/min
10	Pump #1 flow rate	L/min
11	Seismic Air Pressure	Lbs/sq. in.
12	PIR case mv ratiometric output	
13	PIR case thermistor resistance	Ohms
14	Freezer #1 Temp	°C
15	Freezer #1 Temp	°C
16	Freezer #1 Temp	°C

Navigational Data

Seapath GPS (seap & sp2a)

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

- GPZDA
- GPGGA
- GPVTG
- GPHDT
- PSXN, 20
- 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)	

Field	Data	Units
8	Checksum	

GP GGA

02+253:00:00:00.938

GP GGA,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	\$GP GGA	
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	

GP VTG

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	\$GP VTG	
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	

GP HDT

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,20

02+253:00:00:00.942 \$PSXN,20,0.43,0.43*39

Field	Data	Units
1	RVDAS time tag	
2	\$PSXN	
3	20	
4	Horizontal position & velocity quality: 0=normal, 1=reduced performance, 2=invalid data	
5	Height & vertical velocity quality: 0=normal, 1=reduced performance, 2=invalid data	
6	Heading quality: 0=normal, 1=reduced performance, 2=invalid data	
7	Roll & pitch quality: 0=normal, 1=reduced performance, 2=invalid data	
8	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
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

Field	Data	Units
10	K = km per hour	
11	Checksum	

Gyro Compass (gyr1)

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

Field	Data	Units
1	RVDAS time tag	
2	\$HEHDT	
3	Heading, Degrees True	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

Processed Data

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 fractional time of day)	yyyyddd.ttt
3	Raw voltage (IR)	mV
4	Cell temp (C)	°C
5	Barometric pressure (mbar)	MBar
6	CO ₂ conc. (ppm)	ppm
7	Equilibrator Temp (C)	°C

Field	Data	Units
8	pCO ₂ pressure (uatm)	microAtm
9	Flow rate (cc/min)	ml / min
10	Valve Position (integer, note position 9 does not write, defaults to 1)	1 or 2 digits
11	Sample Code number (integer)	1 or 2 digits
12	Flow source (Equil = pCO ₂ measurement)	text
13	RVDAS latitude	degrees
14	RVDAS longitude	degrees
15	TSG external temperature	°C
16	TSG salinity (PSU)	PSU
17	TSG fluorometry (mV -0-5)	V
18	RVDAS true wind speed	m/s
19	RVDAS true wind direction	degrees
20	Barometric Pressure	mBars
21	Uncontaminated seawater pump flow rate	l/min
22	Speed over ground (knots)	knots
23	Course made good (deg)	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 `rvdascal.txt` file and on the calibrations sheets in the appendix.

Calculating Temperature – ITS-90

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

Calculating Conductivity – ITS-90

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

Calculating Fluorometry Voltage

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

Calculating Transmittance

```
Vdark = 0.058 V
Vref = 4.765 V
t = decimal equivalent of bytes 18 - 20
Transmissometer Voltage (Vsignal) = t/819
% Transmittance = (Vsignal - Vdark) / (Vref - Vdark)
```

PAR

```
raw data = mV
calibration scale = 6.27 V/(μEinstiens/cm2sec)
offset (Vdark) = 0.1 mV
(raw mV - Vdark)/scale x 104 cm2/m2 x 10-3 V/mV = μEinstiens/m2sec
or
(data mV - 0.1 mV) x 1.65 (μEinstiens/m2sec)/mV =
μEinstiens/m2sec
```

PIR

raw data = mV

calibration scale = $4.09 \times 10^{-6} \text{ V/(W/m}^2\text{)}$

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

or

data mV $\times 242.1 \text{ (W/m}^2\text{)/mV}$ = W/m^2

PSP

raw data = mV

calibration scale = $7.94 \times 10^{-6} \text{ V/(W/m}^2\text{)}$

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

or

data mV $\times 120.7 \text{ (W/m}^2\text{)/V}$ = 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.

Since this was a sea-trials cruise the magnetometer was frequently deployed and recovered with the seismic equipment. Information for the seismic systems can be found in a separate report for this cruise.

Time	Description
282:19:11	Prepared RVDAS by running New_Cruise for NBP0607C
282:20:48	RVDAS data collection started.
283:18:58	Magnetometer deployed
283:21:43	GFI Circuit outage; magnetometer off
283:54:35	Magnetometer data collection resumed.
284:19:25	Magnetometer data collection stopped for seismic.
285:04:30	Magnetometer data collection resumed.
285:13:30	GFI Circuit outage; magnetometer off
285:13:40	Magnetometer data collection resumed.
286:18:15	30 minute pCO ₂ outage
Day 290	Many instances of weather induced sensor problems
290:01:04	Magnetometer data collection stopped.
291:04:42	Magnetometer data collection resumed.
291:19:03	Magnetometer data collection stopped.
294:05:23	Magnetometer data collection resumed.
294:09:32	Magnetometer data collection stopped. GFP socket tripped.
294:10:03	Magnetometer data collection resumed.
295:20:12	Magnetometer data collection stopped for the remainder of the cruise
296:00:06	NBP0607C RVDAS data collection stopped except for the gravimeter.
296 or 297	Gravimeter run at dock for gravity tie

Appendix: Sensors and Calibrations

NBP0607C Sensors:

Shipboard Sensors

Sensor	Description	Serial #	Last Calibration Date	Comments
Meteorology & Radiometers				
Port Anemometer	RM Young 5106	WM46263	05/20/06	
Stbd Anemometer	RM Young 5106	WM 45834	05/20/06	
Barometer	RM Young 61201	01705	07/15/04	
Humidity/Wet Temp	RM Young 41372LC	06733	06/24/05	
PIR (Pyrgometer)	Eppley PIR	33023F3	01/18/06	
PSP (Pyranometer)	Eppley PSP	33090F3	01/18/06	
PAR (Mast)	BSI-QSR-240	6356	05/16/05	
GUV (Mast)	BSI GUV-2511	25110203114	09/07/05	
PUV (Underwater)	BSI PUV-2500	25000203114	09/07/05	
PRR (Mast)	BSI PRR-610	9696	01/09/04	
PRR (Underwater)	BSI PRR-600	9695	01/09/04	
Underway				
TSG	SeaBird SBE21	218091-1390	03/12/05	
TSG Remote Temp	SeaBird 3-01/S	031497	11/10/05	
Fluorometer	Turner 10-AU-005	5333-FRXX	N/A	
Transmissometer	WET Labs C-Star	CST-439DR	12/09/05	
Gravimeter	LaCoste & Romberg Gravity Meter		n/a	
Bathymetry	Knudsen 320B/R		n/a	
Bathymetry	Bathy 2000		n/a	
Other				
P-Code GPS	Trimble 20636-00 (SM)	0220035116		

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: 10/9/2006 Recalculated
 Location: Lyttelton/Christchurch, New Zealand
 Station: Mag-Obs Workshop, Botanical Gardens
 Latitude: 43 31.77 S
 Longitude: 172 37.18 E
 Elevation: 6.7 meters
 Gravity: 980494.29

Reference Code Numbers:

ADIC 0217-0
 IGC 48732A
 DSIR P11
 GW 79
 NHO 16

	Value	Time (GMT)
Ship's meter before gravity tie (Gravity (cu))	8168.6	0:07
Ship's meter after gravity tie (Gravity (cu))	8168.0	3:45
Average	8168.3	
Ship Gravimeter's Calibration Constant	1.0046	
Corrected ship's meter (QC Grav (mgal))	8205.9	

	Value	Time (GMT)
Ship's meter before gravity tie (serial, RVDAS)	8168.7	0:08
Ship's meter after gravity tie (serial, RVDAS)	8168.1	3:46
Average (for comparison check only)	8168.4	

Portable Gravimeter Correction Multiplier 1.00953 From Table 1 of Model G #807 Meter

Station	Value	Time (GMT)	Temp	Date	OBS mgal, averaged
Pier measurement 1	4123.85	0:46	54	October 9, 2006	
Pier measurement 2	4123.86	0:48	54	October 9, 2006	4163.15
Pier measurement 3	4123.84	0:52	54	October 9, 2006	
Average	4123.85				
Station measurement 1	4092.56	1:45	54	October 9, 2006	
Station measurement 2	4092.55	1:50	54	October 9, 2006	4131.55
Station measurement 3	4092.52	1:55	54	October 9, 2006	
Average	4092.54				
Pier measurement 4	4123.93	3:33	54	October 9, 2006	
Pier measurement 5	4123.92	3:36	54	October 9, 2006	4163.23
Pier measurement 6	4123.95	3:40	54	October 9, 2006	
Average	4123.93				

Gravity offset from last tie 972319.97
 Drift since last tie 0.29

OBS Differences	Value	Comments
Station to Pier (1, 2, & 3 averaged)	31.61	
Station to Pier (4, 5, & 6 averaged)	31.69	
Averaged Differences	31.65	
Gravity at pier	980525.94	
Elevation of pier above gravimeter, meters	0.7	
Earth differential gravity, mgal/meter	0.3	
Gravity at ship's gravimeter	980526.13	
Gravity Offset (for RVDAS)	972320.26	

Gravity tie completed by Sheldon Blackman, Kathy Blackman, Victor Shen and Valerie Park at the Workshop Hut, in the Botanical Gardens in Christchurch. The first set of pier measurements had quite a bit of oscillations due to heavy cargo ops. However, we were able to extrapolate fairly accurately

Meteorology System

Anemometer (Port)

RM Young Anemometer Calibration, Model 05106

S/N: 46263

Date: 20-May-06

Cal'd By: S. Blackman

Clockwise Cal Motor RPM	Calculated Windspeed m/s	Measured Windspeed m/s	Delta m/s	Knots
0	0.00	0.0	0.00	0.0
200	0.98	0.9	0.08	1.9
500	2.45	2.3	0.15	4.8
1000	4.90	4.8	0.10	9.5
1500	7.35	7.2	0.15	14.3
2000	9.80	9.8	0.00	19.0
3000	14.70	14.7	0.00	28.6
4000	19.60	19.7	-0.10	38.1
5000	24.50	24.7	-0.20	47.6
6000	29.40	29.6	-0.20	57.1
7000	34.30	34.6	-0.30	66.6
8000	39.20	39.6	-0.40	76.2
9000	44.10	44.6	-0.50	85.7
10000	49.00	49.5	-0.50	95.2
12000	58.80	59.4	-0.60	114.2

Direction	Measured Direction	Delta Direction
0	0	0
30	30	0
60	60	0
90	90	0
120	120	0
150	150	0
180	180	0
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	0.00
200	0.98	0.8	0.18
500	2.45	2.3	0.15
1000	4.90	4.8	0.10
1500	7.35	7.3	0.05
2000	9.80	9.8	0.00
3000	14.70	14.8	-0.10
4000	19.60	19.7	-0.10
5000	24.50	24.7	-0.20
6000	29.40	29.6	-0.20
7000	34.30	34.6	-0.30
8000	39.20	39.6	-0.40
9000	44.10	44.6	-0.50
10000	49.00	49.5	-0.50
12000	58.80	59.4	-0.60

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

Removed from drawer for installation.
 Calibration checked.

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: 45834

Date: 20-May-06

Cal'd By: S. Blackman

Clockwise Cal Motor RPM	Calculated Windspeed m/s	Measured Windspeed m/s	Delta m/s	Knots
0	0.00	0.0	0.00	0.0
200	0.98	0.8	0.18	1.9
500	2.45	2.3	0.15	4.8
1000	4.90	4.8	0.10	9.5
1500	7.35	7.3	0.05	14.3
2000	9.80	9.8	0.00	19.0
3000	14.70	14.8	-0.10	28.6
4000	19.60	19.7	-0.10	38.1
5000	24.50	24.7	-0.20	47.6
6000	29.40	29.6	-0.20	57.1
7000	34.30	34.6	-0.30	66.6
8000	39.20	39.6	-0.40	76.2
9000	44.10	44.6	-0.50	85.7
10000	49.00	49.5	-0.50	95.2
12000	58.80	59.3	-0.50	114.2

Direction	Measured Direction	Delta Direction
0	0	0
30	29	1
60	59	1
90	89	1
120	119	1
150	149	1
180	180	0
210	210	0
240	240	0
270	271	-1
300	300	0
330	331	-1
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	0.00
200	0.98	0.9	0.08
500	2.45	2.3	0.15
1000	4.90	4.8	0.10
1500	7.35	7.3	0.05
2000	9.80	9.8	0.00
3000	14.70	14.7	0.00
4000	19.60	19.8	-0.20
5000	24.50	24.7	-0.20
6000	29.40	29.6	-0.20
7000	34.30	34.6	-0.30
8000	39.20	39.6	-0.40
9000	44.10	44.6	-0.50
10000	49.00	49.5	-0.50
12000	58.80	59.3	-0.50

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

Removed from drawer for installation and calibration checked.

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: info@eppleylab.com

Internet: www.eppleylab.com

Scientific Instruments
for Precision Measurements
Since 1917**STANDARDIZATION OF
EPPLEY PRECISION INFRARED RADIOMETER
Model PIR**

Serial Number: 33023F3

Resistance: 764 Ω at 23 °C

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

This pyrgeometer has been compared against Eppley's Blackbody Calibration System under radiation intensities of approximately 200 watts meter⁻² and an average ambient temperature of 23 °C as measured by Standard Omega Temperature Probe, RTD#1.

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

$$3.86 \times 10^{-6} \text{ volts/watts meter}^{-2}$$

The calculation of this constant is based on the fact that the relationship between radiation intensity and emf is rectilinear to intensities of 700 watts meter⁻². This radiometer is linear to within $\pm 1.0\%$ up to this intensity.

The calibration of this instrument is traceable to the International Practical Temperature Scale (IPTS) through a precision low-temperature blackbody.

Shipped to: National Science Foundation
Port Hueneme, CA

In Charge of Test:

S.O. Number: 50573

Date: January 18, 2006

Reviewed by:

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

Scientific Instruments
for Precision Measurements
Since 1917

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

Serial Number: 33090F3

Resistance: 699 Ω at 23 $^{\circ}\text{C}$ Temperature Compensation Range: -20° to $+40^{\circ}$ $^{\circ}\text{C}$

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

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

$$8.11 \times 10^{-6} \text{ volts/watts meter}^{-2}$$

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

The calibration of this instrument is traceable to standard self-calibrating cavity pyrheliometers in terms of the Systems Internationale des Unites (SI units), which participated in the Ninth International Pyrheliometric Comparisons (IPC IX) at Davos, Switzerland in September-October 2000.

Useful conversion facts: 1 cal cm $^{-2}$ min $^{-1}$ = 697.3 watts meter $^{-2}$
1 BTU/ft 2 -hr $^{-1}$ = 3.153 watts meter $^{-2}$

Shipped to: National Science Foundation Date of Test: Jan.11,2006
Port Hueneme, CA

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

S.O. Number: 60573
Date: January 18, 2006

Reviewed by: *George L. Kurb*

Remarks:

GUV



GUV-2511 Calibration Certificate

System Serial Number	2511	Date of Calibration	9-07-05
Calibration database	25110203114v3.mdb	Date of Certificate	9/8/2005
DASSN	0069	Standard of Spectral Irradiance	99188
Microprocessor Tag Number	4	Operator	TC

Monochromatic Channels	Address	Wavelength [nm]	Responsivity [Amps per $\mu\text{W}/(\text{cm}^2\text{-nm})$]	ScaleSmall [Volts per $\mu\text{W}/(\text{cm}^2\text{-nm})$]	ScaleMedium [Volts per $\mu\text{W}/(\text{cm}^2\text{-nm})$]	ScaleLarge [Volts per $\mu\text{W}/(\text{cm}^2\text{-nm})$]	OffsetSmall [volts]	OffsetMedium [volts]	OffsetLarge [volts]	Measurement Units
E40320	2	320	2.4952E-10	2.5451E-05	7.4358E-03	1.8718E+00	-1.5175E-04	-1.5535E-04	6.9831E-05	$\mu\text{W}/(\text{cm}^2\text{-nm})$
E40340	6	340	1.9288E-10	1.9671E-05	5.7471E-03	1.8718E+00	1.1280E-04	1.1544E-04	9.0091E-04	$\mu\text{W}/(\text{cm}^2\text{-nm})$
E40313	8	313	2.3926E-10	2.4405E-05	7.1299E-03	2.5028E+00	8.0281E-04	7.8935E-04	-1.4998E-03	$\mu\text{W}/(\text{cm}^2\text{-nm})$
E40305	10	305	1.2875E-11	1.3133E-06	3.8398E-04	1.3188E-01	2.2863E-04	2.3016E-04	8.0671E-04	$\mu\text{W}/(\text{cm}^2\text{-nm})$
E40380	12	380	8.2108E-11	8.3750E-06	2.4466E-03	7.8480E-01	2.1481E-04	2.0369E-04	-2.9957E-04	$\mu\text{W}/(\text{cm}^2\text{-nm})$
E40395	18	400-700	2.9626E-10	3.0218E-05	8.8284E-03	2.7907E+00	2.6231E-04	2.6299E-04	1.1499E-03	$\mu\text{W}/(\text{cm}^2\text{-nm})$

Broadband Channels	Address	Wavelength [nm]	Responsivity [Amps per $\mu\text{E}/(\text{cm}^2\text{-s})$]	ScaleSmall [Volts per $\mu\text{E}/(\text{cm}^2\text{-s})$]	ScaleMedium [Volts per $\mu\text{E}/(\text{cm}^2\text{-s})$]	ScaleLarge [Volts per $\mu\text{E}/(\text{cm}^2\text{-s})$]	OffsetSmall [volts]	OffsetMedium [volts]	OffsetLarge [volts]	Measurement Units
E40PAR	13	0	1.7094E-05	1.7436E+00	5.0941E+02	1.8003E+05	4.1797E-04	4.1364E-04	-6.9777E-04	$\mu\text{E}/(\text{cm}^2\text{-sec})$

Auxiliary Channels	Address	Wavelength	Responsivity	ScaleS	ScaleM	ScaleL	OffsetS	OffsetM	OffsetL	Measurement Units
E40Temp	22	0	1.0000E+00	1.0000E-02	1.0000E-02	1.0000E-02	0.0000E+00	0.0000E+00	0.0000E+00	C
E40Vin	27	0	1.0000E+00	-2.5000E-01	-2.5000E-01	-2.5000E-01	0.0000E+00	0.0000E+00	0.0000E+00	V

⁶ Biospherical Instruments Inc., 5340 Riley Street, San Diego, California 92037 USA. Contact support@biospherical.com for more information.

Calibration Data - Do Not Destroy

page 2 of 2

PAR**Biospherical Instruments Inc.**

CALIBRATION CERTIFICATE

Calibration Date 5/16/2005
 Model Number QSR-240
 Serial Number 6356
 Operator TPC
 Standard Lamp 99189(4/12/05)
 Probe Excitation Voltage Range: 6 to 18 VDC(+)
 Output Polarity: POSITIVE

Probe Conditions at Calibration(in air):

Calibration Voltage: 6 VDC(+)
 Probe Current: 1.2 mA

Probe Output Voltage:

Probe Illuminated 86.9 mV
 Probe Dark 0.1 mV
 Probe Net Response 86.8 mV

Corrected Lamp Output:

Output In Air (same condition as calibration):

8.34E+15 quanta/cm²sec
0.01384 uE/cm²sec

Calibration Factor:

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

Dry: 1.04E-17 V/(quanta/cm²sec)
6.27E+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: 12-Mar-05

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

GHIJ COEFFICIENTS

$g = -3.93226726e+000$
 $h = 4.70569719e-001$
 $i = 6.34631789e-004$
 $j = -9.87772523e-006$
CPcor = -9.5700e-008 (nominal)
CTcor = 3.2500e-006 (nominal)

ABCDM COEFFICIENTS

$a = 4.43616567e-003$
 $b = 4.64684698e-001$
 $c = -3.92316496e+000$
 $d = -8.75063759e-005$
 $m = 2.4$
CPcor = -9.5700e-008 (nominal)

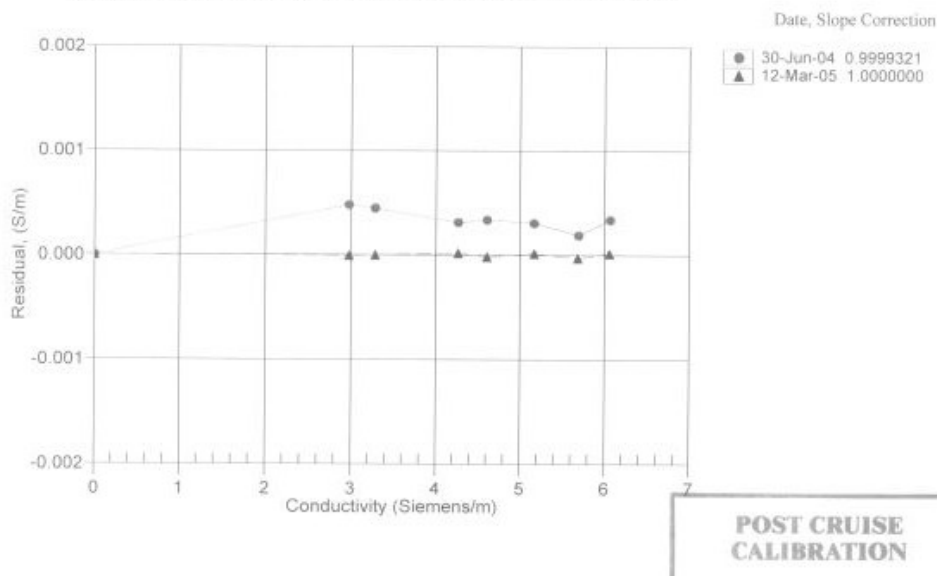
BATH TEMP (ITS-90)	BATH SAL (PSU)	BATH COND (Siemens/m)	INST FREQ (kHz)	INST COND (Siemens/m)	RESIDUAL (Siemens/m)
22.0000	0.0000	0.00000	2.88539	0.00000	0.00000
0.9999	34.7900	2.97392	8.41759	2.97392	-0.00000
4.5000	34.7690	3.28070	8.79114	3.28070	-0.00000
14.9999	34.7244	4.26152	9.89031	4.26154	0.00002
18.5000	34.7146	4.60633	10.24842	4.60632	-0.00002
24.0000	34.7039	5.16375	10.80209	5.16377	0.00001
29.0000	34.6989	5.68525	11.29521	5.68522	-0.00003
32.5000	34.6969	6.05752	11.63436	6.05754	0.00002

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

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

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

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



Underway Temperature Sensor**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: 12-Mar-05SBE21 TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

ITS-90 COEFFICIENTS

$g = 4.21050756e-003$
 $h = 5.95355230e-004$
 $i = 4.97876949e-006$
 $j = -1.73798388e-006$
 $f0 = 1000.0$

ITS-68 COEFFICIENTS

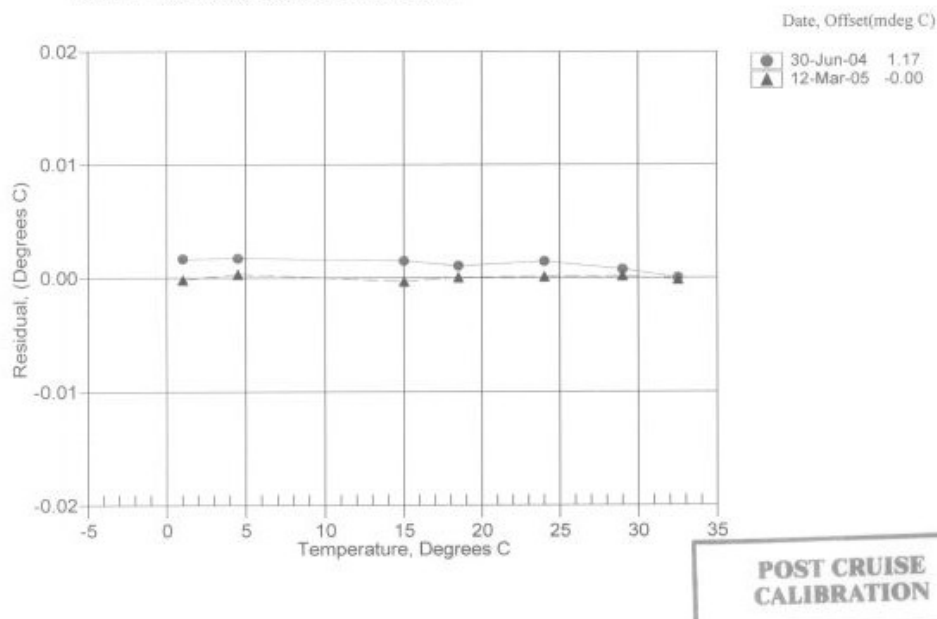
$a = 3.64763867e-003$
 $b = 5.81216773e-004$
 $c = 9.98586302e-006$
 $d = -1.73747972e-006$
 $f0 = 2600.263$

BATH TEMP (ITS-90)	INSTRUMENT FREQ (Hz)	INST TEMP (ITS-90)	RESIDUAL (ITS-90)
0.9999	2600.263	0.9997	-0.00018
4.5000	2814.731	4.5003	0.00033
14.9999	3533.537	14.9996	-0.00033
18.5000	3799.663	18.5000	0.00004
24.0000	4245.995	24.0001	0.00012
29.0000	4682.732	29.0002	0.00018
32.5000	5006.584	32.4998	-0.00016

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

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

Residual = instrument temperature - bath temperature



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

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

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

SENSOR SERIAL NUMBER: 1497
CALIBRATION DATE: 10-Nov-05SBE3 TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

ITS-90 COEFFICIENTS

$g = 4.73766449e-003$
 $h = 6.68793556e-004$
 $i = 2.84645709e-005$
 $j = 2.61326034e-006$
 $f0 = 1000.0$

ITS-68 COEFFICIENTS

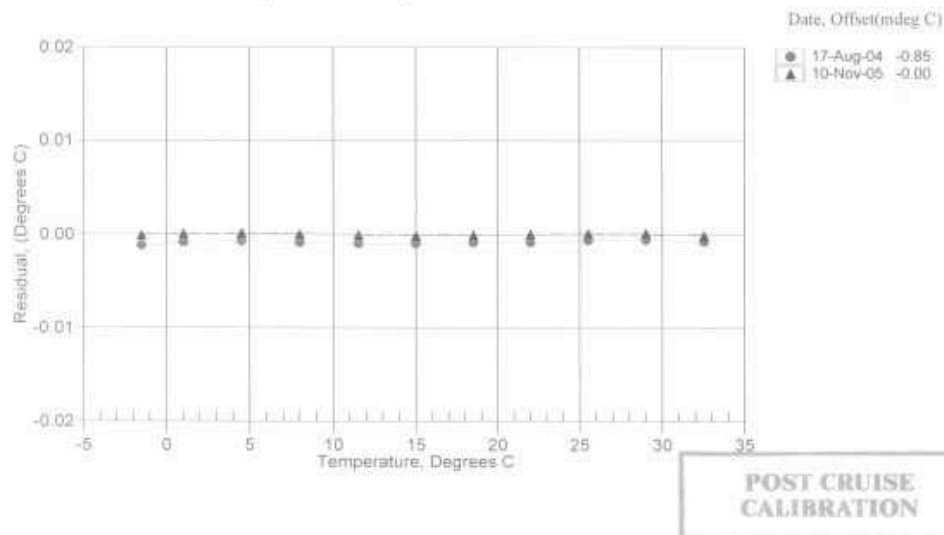
$a = 3.69121909e-003$
 $b = 5.95381666e-004$
 $c = 1.53096888e-005$
 $d = 2.61478510e-006$
 $f0 = 5372.992$

BATH TEMP (ITS-90)	INSTRUMENT FREQ (Hz)	INST TEMP (ITS-90)	RESIDUAL (ITS-90)
-1.5004	5372.992	-1.5005	-0.00010
0.9996	5685.203	0.9997	0.00008
4.4996	6144.063	4.4997	0.00010
7.9996	6628.986	7.9996	0.00004
11.4996	7140.671	11.4995	-0.00006
14.9996	7679.800	14.9995	-0.00015
18.4996	8247.050	18.4995	-0.00005
21.9996	8843.015	21.9996	0.00002
25.4996	9468.305	25.4997	0.00013
28.9996	10123.458	28.9997	0.00012
32.4996	10808.995	32.4995	-0.00013

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

$$\text{Temperature ITS-68} = 1/[a + b[\ln(T_0/T)] + c[\ln^2(T_0/T)] + d[\ln^3(T_0/T)]] - 273.15 \text{ (}^\circ\text{C)}$$
Following the recommendation of JPOTS, T_{th} is assumed to be $1.00024 * T_{90}$ (-2 to 35 $^\circ\text{C}$)

Residual = instrument temperature - bath temperature



Underway Transmissometer

PO Box 518
620 Applegate St.
Philomath, OR 97370



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

C-Star Calibration

Date	December 9, 2005	Customer	National Science Foundation	Work order	007
Job #	0102007	S/N#	CST-439DR	Pathlength	25 cm

	Analog meter
V_d	0.060 V
V_{air}	4.804 V
V_{ref}	4.707 V

Temperature of calibration water	16.9 °C
Ambient temperature during calibration	22.6 °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.

cstarwkbkf1.xls

Revision F

1/17/05