HLY1002 Data Description Summary

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by Dale Chayes, Steve Roberts, and Tom Bolmer

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Chapter 1. Cruise Overview

Introduction

This document is for the Coast Guard Ice Breaker Healy Cruise HLY1003 that left from Point Barrow, Alaska, on September 6, 2010, and ended in Dutch Harbor, Alaska, on September 28, 2010.

The pre-Cruise plan for HLY1002 is described below.

Area of Ops: Canada Basin of the Arctic Ocean, with a focus on the southern part, including within the US and Canadian EEZs.

Primary science objective of the cruise are to support seismic operations on the Louis St. Laurent and to collect morphologic data in support of determining the extended continental shelf of the United States. Multibeam sonar and Chirp subbottom data are critical datasets. The cruise dates are determined to coincide with dates for the Louis S. St-Laurent ECS cruise. This will be a two-icebreaker cruise to continue the data collection that was started in 2008 and continued in 2009. Depending on ice conditions, some of the cruise may have Healy working in one-ship mode in a different area. There is also a chancethat Healy will be used to collect dredge samples in support of ECS studies. The HEALY will also take part in seismic source calibrations at the very beginning of the leg.

If time permits personnel from the National Ice Center will also deploy Metocean ice buoys. The NIC will also carry on a program of routine ice characteristics observations.

Attempts to dredge several bathymetric features mapped in 2007 thru 2009 in order to determine the nature of the crust in these areas. Sampling may include gravity or dart coring of outcrop, and box core or dredge sampling of abyssal seafloor material for evidence of mineral deposits such as manganese nodules.

Underway analysis of seawater and periodic CTD/rosette casts will be used to collect water samples for analysis associated with studies of Arctic Ocean acidification.

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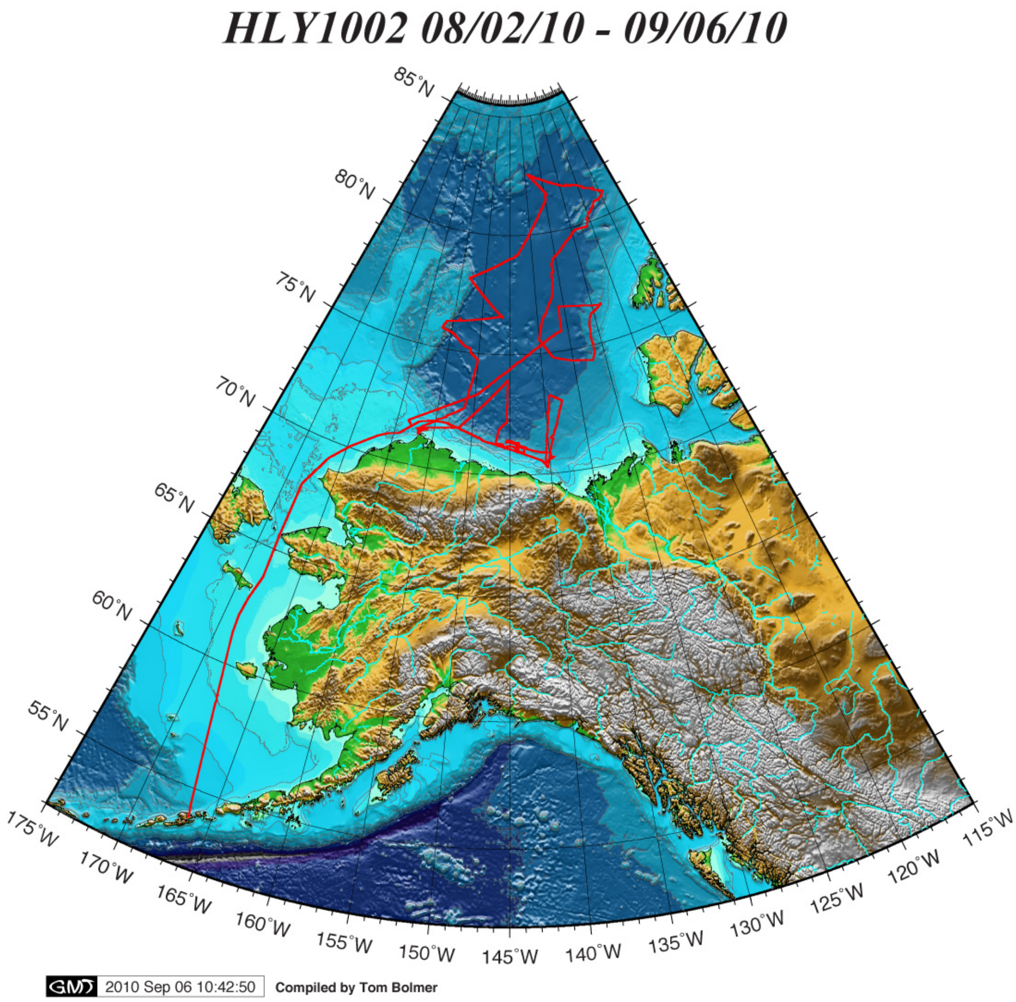
Onboard technical support for science on this leg was provided by Dale Chayes (LDEO/CU), Steve Roberts (UCAR), Tom Bolmer (WHOI) and Eric Burns (USCG - ESU). Bob Arko (LDEO/Columbia University) provided remote support from shore.

Cruise Track

The below track figure shows the full track for the cruise, including the transits.

Figure 1.1. Cruise Track



HLY1002 Science Personnel

Table 1.1. HLY1002 Science Personnel

Name	*Institution*	*Position*	*Phone #*	*email*
Brian Edwards	U.S. Geological Survey	Chief Scientist	650-329-5488	bedwards@usgs.gov
Kwasi Addae	MRAG	marine mammal observer	206-388-6635	Kwasi131@gmail.com
Sarah Ashworth	MRAG	marine mammal observer	206-303-8675	ashwos@gmail.com
Tom Bolmer	WHOI/LDEO/ NSF	Data Specialist	508-289-2628	tbolmer@whoi.edu
Michel Bourdeau	Captain, Canadian Coast Guard	Canadian command liaison	123-456-1234	email
Dale Chayes	LDEO/NSF	Science Systems Engineer	845-365-8434	dale@ldeo.columbia.edu
Jonathan Childs	U.S. Geological Survey	Associate Team Chief Scientist	650-329-5195	jchilds@usgs.gov

Name	***Institution***	***Position***	***Phone #***	***email***
Erin Clark	Canadian Ice Service - Environment Canada	Ice Services Specialist	123-456-1234	erin.clark@ec.gc.ca
Pablo Clemente-Colon	NIC/NOAA	Scientist	301-817-3944	Pablo.Clemente-Colon@noaa.gov
Pete dalFerro	U.S. Geological Survey	Engineering Technician	831-427-4477	pdalferro@usgs.gov
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Christopher Dufore	U.S. Geological Survey	Scientist	727-803-8747x3041	cdufore@usgs.gov
Helen Gibbons	U.S. Geological Survey	Scientist	650-329-5042	hgibbons@usgs.gov
Donny Graham	ESU	Internet Technican	206-617-6692	donny.e.graham@uscg.mil
Ralph Kaleak	BASC	Native community liaison	907-852-4881	basc@arcticscience.org
Sherwood Liu	USF	Scientist	727-553-3922	liu@marine.usf.edu
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Thomas OBrien	U.S. Geological Survey	Scientist	508-457-2246	tobrien@usgs.gov
Caryn Panowicz	NIC	Ice analyst (Louis)	301-394-3028	caryn.panowicz@noaa.gov
Mark Patsavas	University South Florida	Scientist	727-553-3922	mpatsava@mail.usf.edu
Justin Pudenz	MRAG	marine mammal observer	507-822-0576	justinpudenz@Yahoo.com
Steve Roberts	NCAR/LDEO/ NSF	Computer engineer	303-497-2637	sroberts@ucar.edu
William Schmoker	PolarTREC Arctic Research Con.	Teacher outreach	720-201-5749	bill.schmoker@gmail.com
Caroline Singler	NOAA/Teacher-at-Sea	Teacher outreach	508-667-6846	caroline_singler@lsrhs.net
Andrew Stevenson	U.S. Geological Survey	Scientist	360-928-0276	andy@thestevensons.us
David Street	Canadian Hydrographic Service	Hydrogropher	709-726-9280	email
Peter Triezenberg	U.S. Geological Survey	Scientist	650-329-5207	ptriezenberg@usgs.gov
Jenny White	U.S. Geological Survey	Engineering Technician	831-427-4484	jwhite@usgs.gov

HLY1002 Healy Personnel

Table 1.2. HLY1002 Healy Personnel

Name	***Rank***	***Name***	***Rank***	***Name***	***Rank***
William Rall	CAPT	John Reeves	CDR	Eric St. Pierre	LCDR
Ivan Adams	ET3	Tysin Alley	FS3	Brian Apolito	HSCS
Horace Brittle	MST1	Micah Bogdanoff	MK3	Dominique Bondurant	FS2
Evan K. Burgeson	SA	Gregory Caddell	BM1	John Carter	FS1
Marshal Chaidez	MST3	Mark Climacosa	ET1	Richard Cline	EM1
Brittney Coates	FN	Charlene Criss	LT	Nicholas Custer	ENS
Owen Dicks	MST2	Frank Donze	EMCS	Robert Dowd	SN
Jeffery Drzewiecki	LT	Patrick Ettinger	SKC	Jeremy Gainey	ET2
Camille Gavaldon	MK2	Pamela Gilbert	FSCS	Melissa Gomes	FS3
Deidre Gray	SN	Bobby Griffin	SK1	Faith Helfrich	SA
Bethany Hildebrand	SA	Jerry Hirtzel	BM2	Sarah Hohnstadt	ENS
Timothy Horne	OSC	Daniel Howard	DC2	Gaines Huneycutt	BM1
Christopher Imgarten	DC1	Paul Irwin	EM2	Daniel Jarrett	MST2
John Jozwik	A SN	Kenneth Johnson	CWO2	Sven Johnson	ENS
Robert Johnston	ENS	Joash Jones	MK2	Emily Kehrt	ENS
Patrick Kimmel	BM3	Laura King	LCDR	Donald Ladd	EM1
Douglas Lambert	MKC	Paul Lewis	MKCS	Marcus Lippmann	ETCM
Carly Logan	EM3	Scott Logan	BM2	Sean R. Lyons	CWO3
Corey Malloy	MK1	Montarno Mandrie	DC2	Betty Mason	MK2
Gerald McCann	BM2	Jeffrey McCoskey	FN	Holly McNair	ENS
Brian Moller	ETC	Mark Morgan	SK1	John Myers	MK1
James Olson	EM2	Samuel Osburn	MK3	Brandon O'Sullivan	MK1
Andrew Padilla	EM1	John Placido	CWO3	Gregory Powell	ME2
Mitchell Pulatie	DCC	Daniel Purse	MST3	Evan Roy	ME3

Name	***Rank***	***Name***	***Rank***	***Name***	***Rank***
Cary Ryan	BMCM	Chris Schumacher	MK2	Anthony Siciak	ME2
Charles Sinks	ENS	Chris Skapin	LTJG	Evan Steckle	ENS
Kirt Stewart	MSTC	Chris Story	YNC	Scott Titilah	BMC
Miguel Uribarri	IT1	Avery Weston	ENS	Matthew Yosting	DC3
Jerome Hyman	Notice to Mariners	Bob Reiss	English Teacher		

Chapter 2. Distribution Contents

Introduction to Data

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

The structure and organization of the data on the distribution media.

The format and contents of the data strings.

Formulas for calculating scaled, calibrated values from logged data.

Information about the specific instruments in use during the cruise.

A log of instrumentation issues, adjustments , acquisition problems, and events during the cruise that may affect the data.

Calibration data for the instruments in use during the cruise.

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

There are two logging system on the Healy. The US Coast Guard Seattle Electronic Support Unit (ESU) runs the NOAA/SCS logging system and the LDEO support group runs the Lamont Data System (LDS) logging system. Although this provides some redundancy in logging, LDS is is required to provide precision time-stamping, real-time reformatting, and logging of data that SCS was not designed to support including the sonar systems, web cameras, and gravity meters.

The NOAA-developed Scientific Computer System (SCS) (version 4.2) is a data acquisition, and display system designed for Oceanographic, Atmospheric, and Fisheries research applications and was originally intended to log data from supporting sensors (not the mapping sonar's) on survey launches. It acquires sensor data from shipboard oceanographic, atmospheric, and fisheries sensors and provides this information to scientists in real time via text and graphic displays, while simultaneously logging the data to disk for later analysis. SCS also performs quality checks by monitoring I/O, providing delta/range checks and plotting data after acquisition.

The LDEO Data System (LDS) is derived the logging code originally developed on the R/V Conrad in 1986 and has evolved through use on the Conrad, Ewing, Nathaniel B. Plamer, R/V Gould, six SCICEX submarine cruises and a number of smaller, short field programs since 1987. LDS is the result of significant restructuring of the code base in 2004 and has been data acquisition system on the R/V Langseth since she went into service.

SCS Data Overview

SCS receives all of its data through asynchronous serial (RS-232) connections. In SCS a time tag is added at the beginning of each line of data in the form,

mm/dd/yyyy,hh:mm:ss.sss,[data stream from instrument] where:

Table 2.1. SCS Data Overview

Format	Value used
mm	2 digit month of the year
dd	2 digit ay of the year
yyyy	4 digit year

Format	Value used
hh	2 digit hour of the day
mm	2 digit minute
ss.sss	seconds

An example string from the Seabeam Centerbeam file is:

04/13/2007,06:49:20.920,$SBCTR,2007,4,13,06:49:09.437,57.158792,-165.664322 ,69.15,60*00

All times are reported in UTC. Each file type has it's own NEMA string name ($SBCTR as an example).

The delimiters that separate fields in the raw data files are commas. Care should be taken when reprocessing the data that the field's separations are clearly understood.

By design, SCS separates different data records from a single serial data stream into different directories. For instance, a GPS receiver may transmit $GPGGA, $GPHDT, and $GPGLL records. In the SCS data architecture, each of these messages will be logged in a different directory.

LDS Data Overview:

LDS receives most of its data through serial ports like SCS and like SCS, prepends a time stamp. Unlike SCS, LDS uses remote nodes to acquire and timestamp data and provide it to the central LDS logger. Data from the two ship's gyrocompasses is handled by a remote node installed on the bridge and data form the two gravity meters is handled by a node in IC/Gyro. Remote nodes are substantively different than terminal servers in that they timestamp the data locally which eliminates the network latency associated with acquiring data through a terminal server and then providing the timestamp later.

An example LDS data record is shown below. The first field is the instrument identifier, the second is a precioisn time stamp and the remainder is the raw data from the device, in this case, an LDEO iLab BGM-3 gravity meter interface:

bgm222 2008:264:00:00:26.9340 04:025508 00

Directories:

Table 2.2. Directories:

Directory	Description
1_Minute_Averaged_Data:	This directory contains one minute averages of many of the the under way data types.
data:	This directory contains the data directories below.
SCS_Data:	This directory contains serial data collected by the SCS version 4.2 data collection system in different directories. Directory names are labeled by the instrument name and string type of the data collected. A description of the data contained in this directory is below.
LDS_Data:	This directory contains data collected by the Lamont LDS data collection system in different directories. Directory names are labeled by the name of the instrument. A description of the data contained in this directory is below.
Raw:	This directory contains raw data as recorded by individual instruments and put into different

Directory	Description
	directories. Directory names are labeled by the instrument name. A description of the data contained in this directory is below.
Meta_data:	This directory contains documents useful in the post analysis of the data on this DVD media set. The data types are separated into different directories. A description of these directories is below.
Plots:	This directory contain daily and hourly plots of underway data that were generated in LDS.
Satellite_Images:	This directory contains the Satellite images form the Terascan. Directory names are labeled by the data source. A description of these directories is below.
Ice_observations:	Directories of the Ice Observations taken for the cruise.

1_Minute_Averaged_Data:

Table 2.3. 1_Minute_Averaged_Data:

Directory	Description
HLY0901_distance.csv.gz	Distance along track from port.
HLY0901_Averaged.csv.gz	All the Under way data averaged for 1 minute.
Shapefile	All of the 1 minute under way data averaged at 1 minute spacing in shp, shx and dbf GIS files.

data

SCS_Data:

Table 2.4. SCS_Data:

Directory	Description
/aft_a_frame	Wire tension, wire out, and wire speed for the Aft A frame winches.
/air_temp_f	Temperature data from the ship temperature snsor on the bridge in Fahrenheit. Data is derived from data from files in the rmyoung_air directory.
/air_temp3a_f	Temperature data from the MET3A sensor on top of the HCO shack in Fahrenheit. Data is derived from data from files in the met3a_sen directory.
/air_temp_f	Temperature data from the Bridge Temperature Sensor in Fahrenheit. Data is derived from data files in the rmyour_air directory.
/air_temp_bow	Temperature data from the temperature sensor on the Jackstaff in Fahrenheit.
/ashtech_attitude	Attitude in NMEA format from the Ashtech ADU5 GPS receiver.

Directory	Description
/ashtech_gga	Position data in NMEA GGA format from the Ashtech ADU5 GNS receiver.
/ashtech_gll	Position data in NMEA GLL format from the Ashtech ADU5 GNS receiver.
/ashtech_hdt	Heading data in NMEA HDT format from the Ashtech ADU5 GNS receiver.
/baro	Barometer reading for the Bridge Air Pressure Sensor.
/flomet	Flow meter data just upstream of the TSG and Fluorometer.
/flomet_b	Flow meter data just upstream of the B TSG and Fluorometer. (if this second sensor is installed)
/fluro	Flurometer for the TSG sensor.
/fluro_b	Flurometer for B TSG sensor. (if this second sensor is installed)
/gyro_mk27	Heading data in NMEA HDT format from the Sperry MK27 gyro compass.
/gyro_mk39	Heading data in NMEA HDT format from the Sperry MK39 gyro compass.
/isus	ISUS Nitrate Sensor small file.
/isus3v	ISUS Nitrate Sensor 3V full file.
/knudsen	Depth data in a proprietary PKEL format received from Knudsen 320 B/R serial output.
/met3a_sen	Meterology data from the top of the Jackstaff.
/mx512_vtg	Course and speed over ground in NMEA VTG format from the MX512 GNS receiver.
/glonass_gga	Position data in NMEA GGA format from the MX512 GNS receiver.
/mx512_gll	Position data in NMEA GLL format from the MX512 GNS receiver.
/glonass_zda	Time and date data in NMEA ZDA format from the MX512 GNS receiver.
/oxygen	Oxygen values from the TSG.
/oxygen_b	Oxygen values from B TSG. (if this second sensor is installed)
/pcode_aft_gga	Position data in NMEA GGA format from the Trimble Centurion receiver located in the Computer lab.
/pcode_aft_gll	Position data in NMEA GLL format from the Trimble Centurion receiver located in the Computer lab.
/pcode_aft_vtg	Course and speed over ground in NMEA VTG format from the Trimble Centurion receiver located in the Computer lab.
/pcode_aft_zda	Time and date data in the NMEA ZDA format. Data retrieved from the Trimble Centurion receiver located in the Computer lab.

Directory	**Description**
/pcode_bridge_gga	Position data in NMEA GGA format from the Trimble GNS receiver located on the bridge.
/pcode_bridge_gll	Position data in NMEA GLL format from the Trimble GNS receiver located on the bridge.
/pcode_bridge_vtg	Course and speed over ground data in NMEA VTG format from the Trimble GNS receiver located on the bridge.
/posmv_gga	Position data in NMEA GGA format from the POSMV GNS.
/posmv_gst	Pseudorange error statistics in NMEA GST format from the POSMV DNS.
/posmv_hdt	Heading data in NMEA HDT format from the POSMV GNS.
/posmv_pashr	Roll, pitch and heave from POS MV inertial navigation system.
/posmv_vtg	Course and speed over ground in NMEA VTG format from the POSMV GNS.
/posmv_zda	Time and date data in NMEA ZDA format from the POSMV GNS.
/pressure_sen	Pressure sensor in the Uncontaminated Seawater System before the Bio Chem Lab which measures header pressure in PSI.
/rmyoung_air	Temperature, humidity, air pressure data in NMEA XDR format from the ship RM Young meteorological system near the bridge.
/rmyportwind	Wind speed and direction data in NMEA WMV format from the ship RM Young weather vane on the port side of the Healy Mast Yard.
/rmystbdwind	Wind speed and direction data in NMEA WMV format from the ship RM Young weather vane on the starboard side of the Healy Mast Yard.
/samos_data	Meterology data for SAMOS.
/solar_radiometers	Solar Radiometer data for SW and IW.
/sperry_speedlog	Ground/water speed data from the Sperry Speed Log.
/stbd_a_frame	Wire tension, wire out, and wire speed for the starboard A frame winches.
/surface_par	Photosynthetic Active Radiation volts and Microeinstens/m2 se from the surface par sensor.
/surface_temp	Water Temperature at the Science Sea Water Intake..
/temp_incubat	Temperatures from the Incubators.
/true_wind_port	True wind speed data derived from gyro data and rmyportwind.
/true_wind_stbd	True wind speed data derived from gyro data and rmystbdwind.
/tsg	Thermosalinograph and fluorometer data from the TSG instruments in the Bio/Chem Lab.

Directory	Description
/tsg_b	Thermosalinograph and fluorometer data from the B TSG instruments in the Bio/Chem Lab. (if this second sensor is installed)
/wind_bow	Wind data from the UltraSonic wind sensor on top of the Jack Staff.
/wind_mid	Wind data from the UltraSonic wind sensor on the Yard.

Extra files in the directory SCS_Data:

Table 2.5. Extra files in the directory SCS_Data:

Directory	Description
Acq.log	Contains the data as to what occurred with SCS data. It shows when data collection was started and stopped. Includes startup and shutdown events.
Incidents_YYYYMMDD-TTTTTT.DTM	Contains any incident data, which were triggered in SCS. Refer to the SCS documentation for the definition of incidents.
sensor_YYYYMMDD-TTTTTT.scf	Contains the configuration file for data collection as configured by SCS.

LDS_Data:

Table 2.6. LDS_Data:

Directory	Description
/AloftConCam	Contains picture files separated by folders named by Year and Day of the Year (YYYYJJJ). The picture files are in JPEG format for every minute.
/FantailCam	Contains picture files separated by folders named by Year andDay of the Year (YYYYJJJ). The picture files are in JPEG format for every minute.
/adcp_nav	Contains the navigation data sent to the ADCPs.
/adu5	Contains the data from the ADU5 GNS.
/aggps	Contains the data from the AG GNS.
/ais	Contains the AIS data from the bridge.
/bgm221	Contains the data from the BGM221 Gravimeter.
/bgm222	Contains the data from the BGM222 Gravimeter.
/cnavp	Contains experimental C-Nav 3050 Globally Corrected Differential GNSS, Port reciever.
/cnaps	Contains experimental C-Nav 3050 Globally Corrected Differential GNSS, Starboard reciever.
/em122	Contains the raw EM122 data
/emctr	Contains the EM12 Nadir depth
/emctr2udp	Empty directory

Directory	Description
/emsv	Contains the Surface Sound Speed of Sea Water calculalted from the Intake Temperature and the Salinity of the TSG sensor in BioChem.
/events	Contains logs of events in the operation of LDS.
/gpgga_out	Empty directory
/ibs_waypoints	Waypoints from the Healy's Integrated Bridge
/iceview	Empty directory
/mk27	Contains the data from the MK27 Gyro.
/mk39	Contains the data from the MK39 Gyro.
/posnav	Contains the navigation data from the POSMV GNS.
/posnav2	Contains the navigation data from the Second POSMV GNS.
/tsg	Contains the output for the TSG in BioChem.
/tsg_met	Contains the all data from SIO TSG and Met sensors.
/winch_aft	>Wire tension, wire out, and wire speed for the Aft A frame winches.
/winch_stbd	Wire tension, wire out, and wire speed for the Starboard A frame winches.

Raw:

Table 2.7. Raw:

Directory	Description
Directory	Description
/adcp150	150 Khz ADCP and 75 KHz ADCP data.
/ctd	CTD data in directories by Cast number.
environmental_sensors	Temperature and Humidity Sensor data for the Climate control chambers
/knudsen	Knudsen 320B/R data.
/xbt	Expendable Bathythermograph data.
/xctd	Expendable CTD data.

Satellite_Images:

Table 2.8. Satellite_Images:

Directory	Description
/dmsp	Data from the Defense Meteorology Satellite Program passes logged by the Healy's Terascan . Directories are identified by Year, Month, Day.
/hrpt	Data from the NOAA weather satellite passes logged by the Healy's Terascan . Directories are identified by Year, Month, Day.

Meta_Data:

Table 2.9. Meta_Data:

Directory	Description
/elog	Contains the technical support staff narrative of important events, which occurred both to the network and to individual sensors.
/Bridge_Logs	
DDMMMYY.doc	The "smooth log" containing events recorded by the bridge watch.
DDMMMYYWX.xls	Weather log recorded by the watch.
DDMMMYYNAV.xls	Navigation logs recorded by the watch.
/Sensor_Formats	Contains html and PDF files documenting the formats of all the files collected under way during the cruise.
./Systems_Calibrations	All of the calibrations sheets for the underway instruments are here.
./WHOisWHO	The directory has information about contacts for the Science personnel on this cruise.

SVP:

Sound speed profiles used for the EM122

Plots:

Table 2.10. Plots:

Directory	Description
./knudsen_hourly_plots:	Directories of the SIOSEIS plots of the Knudsen 3.5 kHz data are in directories named by year, month, and day. These images are in the png format. There are two plots for each window in time. One is a large sized plot and one is a smaller plot. The files start 10 minutes before the file name and 10 minutes after the hour the file is named for. The Time axes use Two-Way Travel Time. The Speed of Sound used is 1500 m/sec. To get the depth in meters from these plots multiply the time depth by 750.
./surface_daily_plots	Directories containing daily plots of under way data.

Ice_observations:

Directories of the Ice Observations taken for the cruise.

File Formats of Data Collected Underway

The formats of the Under way data files that were collected on this cruise are in a separate document named using the cruise name (like: HLY1001_Sensors). This is a separate document and not included in this document due to its large size. An html version of this file can be found in the Meta_Data directory. A PDF version of this file is also here. To use the html file you will need to have the directory (HLY1001_Sensors_files) w hich contains images and other files needed in the html page in the same directory as the html file.

Chapter 3. Merged Data

LDEO Averaged One Minute Data File

The data are summarized into an averaged one (1) minute data file by the LDEO technician. This file takes the average value centered on the minute, (30 seconds either side of the whole minute). The averages are calculated from the raw values as they are logged. There has been no quality control done on these files prior to the averaging. Those wishing more accurate and quality controlled values should process the data in the directories described below in the document. See the below NOTE.

This entry is an example of a 1 minute averaged file from the LDEO Technican. Use the header information in the file for your cruise to see what your file contains.

HLY0902_track.csv

6489,2009/04/06
10:45,58.7901313,-168.7344088,12.6,6.9,15.4,52.5,-1.686,11.760,0.1640,0.105,0.090,0.009,0.00,1.22,325.99,273.48,2

6490,2009/04/06
10:46,58.7919917,-168.7336473,11.2,6.9,13.6,51.5,-1.686,11.866,0.1676,0.107,0.090,0.009,0.00,1.22,326.29,273.46,2

6491,2009/04/06
10:47,58.7938830,-168.7329548,10.5,6.9,12.6,52.2,-1.686,11.970,0.1717,0.110,0.090,0.009,0.00,1.22,325.92,273.46,2

Table 3.1. LDEO Averaged One Minute Data File

Field	Data	Example	Units
01	ID	6489	sample count
02	date 2009/04/06	10:45	date time UTC (year/month/day hour:minute)
03	lat	58.7901313	$INGGA, POSMV Latitude (decimal degrees)
04	lon	-168.7344088	$INGGA, POSMV Longitude (decimal degrees)
05	cog	12.6	$INVTG, POSMV Course Over Ground (angular distance from 0 (North) clockwise through 360, 1 minute average)
06	sog	6.9	$INVTG, POSMV Speed Over Ground (Knots, 1 minute average
07	heading	15.4	$PASHR, POSMV ship heading(angular distance from 0 (North) clockwise through 360, 1 minute average)
08	depth	52.5	$SBCTR, Seabeam centerbeam

Field	Data	Example	Units
			depth(meters, 1 minute average)
09	SST	-1.686	$PSSTA, SBE3s RemoteTemperature, Sea Chest intake (Celsius, 1 minute average)
10	TSG_InTemp	11.760	$PSTSA, SBE45 Water Temperature (Celsius, 1 minute average)
11	TSG_Cond	0.1640	$PSTSA, SBE45 Water Conductivity (millisiemens/ centimeter, 1 minute average)
12	TSG_Sal	0.105	$PSTSA, SBE45 Water Salinity (PSU, 1 minute average)
13	SCF-FL	0.090	$PSFLA, Seapoint Fluorometer (Ug/l, 1 minute average)
14	SCF-FL-V	0.009	$PSFLA, Seapoint Fluorometer (Volts, 1 minute average)
15	tsg_flow_A	0.00	$PSFMA, Flowmeter in-line with PSTSGA, PSOXA, PSFLA (LitersPerMinute, minimum value in 1 minute interval)
16	SWR	1.22	$PSSRA, Short Wave Radiation (W/M^2, 1 minute average)
17	LWR	325.99	$PSSRA, Long Wave Radiation (W/M^2, 1 minute average)
18	LWR_Dome_T	273.48	$PSSRA, LWD Dome Temperature (Deg K, 1 minute average)
19	LWR_Body_T	273.42	$PSSRA, LWD Body Temperature (Deg K, 1 minute average)
20	PAR	1.66	$PSSPA, Surface PAR (uE/Sec/M^2, 1 minute average)
21	JS_Air_Temp	0.13	$PSATC, Bow Jackstaff Air Temperature (Deg C, 1 minute average)
22	Bridge_RH	99.71	$PSMEB, Bridge RM Young Relative

Field	Data	Example	Units
			Humidity (%, 1 minute average)
23	Bridge_Baro	999.75	$PSMEB, Bridge RM Young Barometric Pressure (millibars, 1 minute average)
24	JS_WndDirR	116.25	$PSWDC, Jackstaff Relative wind direction (deg, 1 minute average)
25	JS_WndSpdR	4.32	$PSWDC, Jackstaff Relative wind speed (m/s, 1 minute average)
26	JS_WndDirT	160.66	$PSWDC, Jackstaff True wind direction (deg, 1 minute average)
27	JS_WndSpdT	6.68	$PSWDC, Jackstaff True wind speed (m/s, 1 minute average)
28	MM_WndDirR	117.60	$PSWDB, Main Mast Relative wind direction (deg, 1 minute average)
29	MM_WndSpdR	3.82	$PSWDB, Main Mast Relative wind speed (m/s, 1 minute average)
30	MM_WndDirT	164.25	$PSWDB, Main Mast True wind direction (deg, 1 minute average)
31	MM_WndSpdT	6.31	$PSWDB, Main Mast True wind speed (m/s, 1 minute average)
32	SBE_Oxy	5.809	$PSOXA, SBE-43 Oxygen(ml/l, 1 minute average)
33	SBE_Oxy_Raw	2.148	$PSOXA, SBE-43 Oxygen(Volts, 1 minute average)
34	SBE_Oxy_T	11.814	$PSOXA, SBE-43 Oxygen Temperature(Deg C, 1 minute average)
35	WinchAft	2	Aft A-Frame Winch number
36	TensionAft	-76	Aft A-Frame Winch Wire tension(Pounds, 1 minute average)
37	WireOutAft	-6	Aft A-Frame Winch Wire out (Meters, 1 minute average)
38	SpeedAft	0	Aft A-Frame Winch Wire speed(Meters/

Field	Data	Example	Units
			minute, 1 minute average)
39	WinchSbd	1	Starboard A-Frame Winch number
40	TensionSbd	-60	Starboard A-Frame Winch Wire tension(Pounds, 1 minute average)
41	WireOutSbd	1	Starboard A-Frame Winch Wire out (Meters, 1 minute average)
42	SpeedSbd	0	Starboard A-Frame Winch Wire speed(Meters/minute, 1 minute average)
43	StbdWndSpdT	13.25	RMYoung True Wind Speed, starboard(Knots, 1 minute average)
44	StbdWndDirT	162.1	RMYoung True Wind Direction, starboard(angular distance from 0 (North) clockwise through 360, 1 minute average)
45	OxySat	7.58	Dissolved oxygen (DO) saturation as a funciton of T and S (Weiss)(ml/L, 1 minute average)

Use these with caution.

Appendix A. Appendix

Acquisition Problems and Events (Elog)

A electronic logbook (elog) is utilized on the ship for logging of science related problems and events as they happen. A dump of the logbook is done at the end of the cruise and saved in the Meta_Data directory under the “elog” subdirectory. Two logbooks are kept: one by the technical support personnel and one by the science party watch standers, if there were any at the watch standers station for the cruise. Several dump formats are made available such as html, csv, xml and raw. These logs should be consulted to help identify instrument and system anomalies affecting data quality. Times are reported in GMT (UTC, Z).

Below here is a summary of technical logbook. For exact details you should check the files in elog. The science watchstanders log is not summarized here. The user should also look in the full Elog files distributed on the USB Disk drive.

When two logs, one for the technicans and one for the science party, are kept, the logs may be intermixed for the cruise. Care must be taken to use both logs in keeping track of problems.

In the Meta_Data directory there may be some PDF files for data that was collected but not part of the normal science routine.

Table A.1. Acquisition Problems and Events (Elog)

Date	Time(UTC)	Comment
08/02/10	10:28	Start SCS logging for HLY1002
08/02/10	17:39	Start LDS logging for HLY1002, except winches
08/02/10	23:23	Start Knudsen, Pulling away from dock.
08/02/10	23:24	Start EM122 pinging
08/02/10	23:49	EM122 SIS HDDS.exe crashed. Restart HDDS
08/03/10	00:11	ECC start Science Sea Water.
08/03/10	01:30	M122 SIS complain loss of nav. both POSMV "lost Communications" warning.
08/03/10	02:57	SubBotom lost, reset windows.
08/03/10	10:46	EM122 new SSP woa_1675W565N_Aug.asvp.
08/03/10	13:23	EM122 new SSP woa_1675W575N_Aug.asvp.
08/03/10	14:45	EM122 Position lost warning.
08/03/10	20:15	EM122 SIS Tear down menu boxes not work.
08/03/10	20:34	POSMV #1 reset. Large negative attitude.
08/04/10	00:49	MK27 and 39 data stopped. Bridge network switch problem.
08/04/10	02:06	MK27 and 39 data working. Bridge network switch restarted.

Date	**Time(UTC)**	**Comment**
08/04/10	15:33	EM122 New SSP woa_169W_665N_Aug.asvp.
08/05/10	01:20	EM122 New SSP woa 168.5W 66.5N, Does not look good.
08/05/10	06:52	EM122 New SSP woa 168.5W 68.5N.
08/05/10	08:21	EM122 position lost warning.
08/05/10	14:56	EM122 new SSP tried, so bad removed.
08/05/10	16:04	EM122 new SSP from HLY1001 CTD tried, so bad removed.
08/05/10	20:40	EM122 new SSP 1474 isospeed.
08/06/10	03:30	EM122 new SSP WOA 164.5W 69.5N.
08/06/10	05:50	EM122 new SSP WOA 163.5W 71.5N.
08/06/10	06:00	LDS logger created for TSG direct from BioChem called tsg.
08/06/10	08:37	EM122 new SSP WOA 157.5W 71.5N.
08/06/10	10:20	EM122 SIS restart. New survey HLY1002_2.
08/06/10	17:41	EM122 new SSP woa_1562W_725N_Aug.asvp.
08/06/10	23:03	EM122 SIS Stopped generating bottom depth and profile. Stopped pinging and restarted. Working again.
08/06/10	23:04	EM122 new SSP using HLY1002 XBT T7_00084.
08/07/10	02:52	EM122 new SSP woa_150.5W 72.5N.
08/07/10	11:57	EM122 new SSP woa_147.5W 71.5N woa_1475W_715N_Aug.asvp.
08/07/10	12:00	POSMV not receiving RTCM messages.
08/07/10	20:30	EM122 new SSP using HLY1002 XBT T7_00085.
08/07/10	21:06	EM122 new SSP using HLY1002 XBT T7_00085 deep and WOA 138.5W 70.5N upper 50m.
08/07/10	22:51	EM122 reuse SSP HLY1002 XBT T7_00085.
08/08/10	03:01	EM122 new SSP using HLY1002 XBT T7_00086.

Date	**Time(UTC)**	**Comment**
08/08/10	18:36	EM122 new SSP using WOA 138.5W 72.4N (for July) and HLY1002 XBT T7_00086 for below 75m.
08/09/10	04:08	Science Sea Water changed to allow for ice.
08/09/10	07:09	Start LDS winch loggers.
08/09/10	15:45	No realtime MB plotting in Mapserver.
08/09/10	18:29	EM122 BIST tests. TX36, TRO power and TX Channels fail.
08/09/10	21:25	EM122 new SSP using HLY1002 CTD 001.
08/10/10	04:48	Terascan WDS system appears to be down.
08/10/10	15:45	EM122 reuse SSP WOA 18.55W 70.5N.
08/10/10	20:49	Science Seawater System open another valve in BioChem sink to reduce latency.
08/11/10	10:55	ADU5 stopped reporting at 10:01. Reset at 10:43.
08/11/10	12:54	Stop and restart Mapserver realtime gridding after about 2hours of not plotting.
08/11/10	14:48	EM122 re-enter SSP using HLY1002 XBT T7_00085.
08/11/10	17:00	EM122 re-enter SSP using WOA 138.5W 70.5N.
08/12/10	16:42	Science Se Water flow adjusted.
08/13/10	05:44	Science Se Water flow adjusted after a pump shot of and as restarted.
08/13/10	14:10	EM122 SSP from XBT89 add HLY1002_WOA, edited in 1440 down to 7.9.
08/13/10	19:21	EM122 Last SSP Corrected using Levitus Salinity.
08/14/10	21:48	EM122 New SSP using XBT 90, WOA and CTD 001.
08/14/10	23:09	Science Sea Water Biochem relief valve adjusted.
08/15/10	19:08	EM122 New SSP using XBT 91, WOA and CTD 001.
08/15/10	21:04	EM122 New SSP using XBT 92, WOA and CTD 001.
08/16/10	08:08	EM122 New SSP using XBT 93.
08/16/10	19:33	Note no MK39 or 27 available.

Date	Time(UTC)	Comment
08/16/10	22:09	EM122 Last SSP Corrected using XBT 93 and CTD 001.
08/16/10	23:07	ADU5 stopped. Resetting did not restart.
08/16/10	23:40	EM122 New SSP using XBT 84 and 94, WOA and CTD 001.
08/17/10	02:37	ADU5 taken offline at 01Z for debugging.
08/17/10	02:40	Knudsen not getting nav due to ADU5 offline.
08/17/10	12:20	POSMV lost WAAS corrections.
08/17/10	12:29	POSMV WAAS corrections back.
08/17/10	17:05	EM122 New SSP using XBT 95.
08/18/10	11:58	Stop and restart Mapserver realtime gridding since not plotting.
08/18/10	21:21	EM122 New SSP from XBT 98 HLY1002_T7_00098.asvp. WOA Salinity used and CTD 001 for deep.
08/19/10	05:07	Lost connection to POSMV #1.
08/19/10	05:13	POSMV #1 back working.
08/19/10	05:36	Lost connection to POSMV #1.
08/19/10	06:03	POSMV #1 back working.
08/19/10	07:16	Terascan enable KG44A DMSP encryption.
08/19/10	14:45	Stop and restart Bridge Helsman display.
08/19/10	18:21	EM122 SIS stop and restart due to not pinging due to bad force depth values.
08/19/10	19:36	EM122 New SSP from XBT 99 HLY1002_T7_00099.asvp. WOA Salinity used and CTD 001 for deep.
08/19/10	21:24	Terascan back in unecrypted bypassing KG44A.
08/20/10	07:54	Terascan enable KG44A DMSP encryption.
08/20/10	10:59	POSMV #2 is standalone mode.
08/20/10	11:06	POSMV #2 is DGPS back.
08/20/10	20:33	EM122 New SSP from XBT 100 HLY1002_T7_00100.asvp. Levitus Salinity used and Levitus for deep.

Date	Time(UTC)	Comment
08/20/10	21:41	Terascan back to unencrypted.
08/21/10	06:48	EM122 New SSP from XBT 102 HLY1002_T7_00102.asvp. CTD 5 Salinity used and Levitus for deep.
08/21/10	07:23	Terascan back to encrypted.
08/21/10	21:02	Terascan back to unencrypted.
08/22/10	07:12	Terascan back to encrypted.
08/22/10	14:42	POSMV #2 not reporting data.
08/21/10	19:40	EM122 New SSP from XBT 103 HLY1002_T7_00103.asvp. CTD 6 Salinity used and CTD 6 for deep.
08/21/10	20:48	Terascan bypass KG44A for DMSP.
08/23/10	07:50	Mapserver realtime gridding needed to be restarted.
08/23/10	07:51	Terascan KG44A reconnected.
08/23/10	20:57	Terascan bypass KG44A for DMSP.
08/23/10	22:01	POSMV #2 update firmware. Restart with no success.
08/24/10	00:28	Subbototm recording directory changed since was restarted with wrong one.
08/24/10	05:07	EM122 New SSP from XBT 106 HLY1002_T7_00106.asvp. Levitus Salinity used and CTD 6 for deep.
08/24/10	07:47	Terascan KG44A reconnected.
08/24/10	09:33	Mapserver realtime gridding needed to be restarted.
08/24/10	16:54	Reinstall 10Mps switch for POSMV #1.
08/24/10	20:26	Terascan bypass KG44A for DMSP.
08/24/10	22:54	Stop and restart Bridge Helsman display.
08/25/10	04:40	Terascan KG44A reconnected.
08/25/10	10:59	Mapserver realtime gridding needed to be restarted.
08/25/10	11:57	Mapserver realtime gridding needed to be restarted.
08/25/10	20:13	EM122 New SSP from XBT 107 HLY1002_T7_00107.asvp. WOA Salinity used and CTD 6 for deep.

Date	Time(UTC)	Comment
08/25/10	21:54	Terascan bypass KG44A for DMSP.
08/26/10	04:31	Terascan KG44A reconnected.
08/26/10	10:10	EM122 New SSP from CTD 1 HLY1002_CTD_0007.asvp. Levitus used for deep.
08/26/10	13:56	ADU5 Heading stopped. Reset ADU5 in HCO.
08/26/10	21:40	Terascan bypass KG44A for DMSP.
08/27/10	02:36	POSMV #2 back after another firmware rev installed.
08/27/10	03:37	Terascan KG44A reconnected.
08/27/10	18:28	EM122 New SSP from CTD 8 HLY1002_CTD_00008.asvp. Levitus used for deep.
08/27/10	18:55	EM122 Stop logging. Run BIST tests.
08/27/10	19:02	EM122 resume logging.
08/27/10	20:04	Note Starboard Wind bird iced over and bad data.
08/27/10	21:33	Terascan bypass KG44A for DMSP.
08/28/10	05:36	Terascan KG44A reconnected.
08/28/10	20:13	Terascan reboot WDS system. Not getting usable passes.
08/28/10	21:21	Terascan bypass KG44A for DMSP.
08/29/10	01:26	XBT 108 may not have data since GUI froze after hitting the SAVE button.
08/29/10	03:02	XBT 108 was able to be saved successfully.
08/29/10	03:14	POSMV, both logging PosPAC data for performance evaluation.
08/29/10	03:26	EM122 New SSP from XBT 108 HLY1002_T5_00108.asvp. CTD 8 and Levitus used for deep.
08/29/10	04:35	Terascan KG44A reconnected.
08/29/10	06:55	Mapserver realtime gridding restarted since it didn't seem to be updating.
08/29/10	14:43	POSMV #2 accuracy light red.
08/29/10	18:23	EM122 note raw data logged by LDS has small % of datagrams missing compared to raw data on the SIS PC.

Date	Time(UTC)	Comment
08/29/10	20:58	Terascan bypass KG44A for DMSP.
08/29/10	22:52	HCO antennas noted to be coming lose. Antennas secured with ratchet straps.
08/30/10	03:54	Terascan KG44A reconnected.
08/30/10	05:51	EM122 SIS PC froze dong md5sum;s. Needed to hit reset button. SIS restarted.
08/30/10	20:58	Terascan bypass KG44A for DMSP.
08/30/10	21:23	Terascan reset GPS and ACU connections in the antenna dome. GPS data coming in again.
08/31/10	04:16	Terascan KG44A reconnected.
08/31/10	05:43	EM122 New SSP from XBT 109 HLY1002_T7_00109.asvp. CTD 6 used for salinity and deep.
08/31/10	07:44	Mapserver realtime gridding restarted since it didn't seem to be updating.
08/31/10	18:15	EM122 to standby for BIST tests.
08/31/10	18:24	EM122 back on line.
08/31/10	19:37	Terascan bypass KG44A for DMSP.
08/31/10	20:33	EM122 Bridge Helmsman showed ERROR on screen. Stop and restart Helmsman program on Bridge.
09/01/10	04:40	EM122 New SSP from XBT 110 HLY1002_T5_00110.asvp. CTD 6 used for salinity and deep.
09/01/10	07:04	Terascan KG44A reconnected.
09/01/10	12:39	Stop and restart Firefox on Bridge Mapserver computer since it was "sluggish".
09/01/10	18:57	Stop and restart Mapserver realtime gridding script.
09/01/10	20:09	EM122 New SSP from XBT 111 HLY1002_T5_00111.asvp. CTD 6 used for salinity and deep.
09/01/10	20:23	Terascan bypass KG44A for DMSP.

Date	Time(UTC)	Comment
09/02/10	00:07	POSMS #2 heading accuracy growing.
09/02/10	02:02	POSMS #2 reset. Working better.
09/02/10	04:13	Terascan KG44A reconnected.
09/02/10	20:45	Terascan bypass KG44A for DMSP.
09/03/10	20:16	EM122 New SSP from CTD 10 HLY1002_CTD_00-10.asvp. CTD 6 used for and deep.
09/03/10	07:05	Terascan KG44A reconnected.
09/03/10	11:48	Stop and restart Mapserver realtime gridding script.

Comments about the data

General Comments about Healy data

The SCS system has to be stopped when fixing some kinds of issues. If this is the case, you should consult the elog entries for possible explanations and look for the corresponding data in the LDS_Data dir.

The Knudsen data written into SCS_Data/knudsen often has an inconsistent time in the data. The time that the SCS writes to the start of the KEL file should be used. The Knudsen internal clock adds about 22.8 seconds to the internal clock each day near 00:00. But this is reset when the recording program is started up and when watchstanders manually synchronize the time. Use only the SCS time stamp for time in this data and it should be fine. The accuracy of the time in the SEG-Y files and KEB files should be inspected and compared to the time-stamped KEL records. The time stamp from SCS is when the information when the data is written. The Kel file time data is when the the ping was transmitted.

The EM122 Multibeam data is raw and unedited. Depending on the intended use, this data may need processing, including but not necessarily limited to editing . Like nearly all multibeams, but not as bad as some, the EM122 has issues with the near-nadir beams: the bathymetry tends to be less repeatable in the near-nadir region compared to the middle of the swath. The outer beams are noisier in the icebreaker EM122 installations than those installed on non-icebreakers.. The acoustic noise of breaking ice, plus bubble-sweep down due to the shape of the bow, and masking by ice sliding under the hull all contribute to degrading the data quality while operating in ice.

The Knudsen subbottom data is not an accurate source of water depth for a number of reasons, including the fact that it is always recorded using a sound speed of 1500 meters/second, because the beam pattern is large (30 to 60 degrees), because of it’s bottom detection algorithm, and because, by design, it penetrates the seafloor.

Both the mechanical windbirds and the ultrasonic anemometers can spend much of the trip iced up when in sub-freezing weather. Care should be taken when using the data from the wind sensors. The ultrasonic anemometers are heated which helps reduce freezing issues. Depending on the relative wind direction, different wind speed and direction sensors provide more realistic estimates of the actual wind. The same goes for temperature: stack gas driven by the wind, and heating from the ship when there is no wind can make signficant differences in the measured values.

During the cruise various parties could be changing the water flow in the Science Sea Water system to adjust the system’s response to various flow rates in response to icing and/or filling adjusting flow to the incubators depending on the cruise. This changes the amount of water going through the TSG and has discernable impact on the measurements taken. You should closely follow the Elog entries for the TSG and Science Sea Water in the Elog section in the Meta_Data directory to see when water flow rates were adjusted. These events are not always accurately entered into Elog. These flow rate changes should affect all of the TSG data and care should be taken when using the TSG data.

The POSMV navigation system reports location as the Healy's Master Reference Point (MRP) and not at the antenna locations above the Helicopter Control Shack (HCO). The Master Reference Point is in IC/ Gyro (down by the Gym and Laundry) and can be seen in the diagram at the end of this document showing instrument locations on the ship.

Specific Comments about this cruise

As is always the case, there were issues with data from this cruise. This section

POS/MV

The new POS/MV was not used during this cruise but was operated to see how it ran. It stopped working for several days until a new Firmware version could be recieved from shore and installed.

EM122 multibeam

The EM122 system worked well this cruise. A problem was discovered with the data that was repeated and writen to the Raw data directory. These files have missing sections in them. The files have "complete" pings in that they are indivivual units. But there are missing parts to them. The data on the SIS computer does not have this problem. An esitmate of perhaps 1/2 a percent of the data has this problem. The data from SIS computr will be copied to the raw EM122 data directory so that full, complete, files will be saved. This may be due to an eror in the SIS program and needs to be investigated. Care must be taken to be sure when using the EM122 data that the daa used is the data cpoied form the SIS computer and not recorded as broadcast dtagrams from the SIS program.

Met System

There were some events during this cruise when the Met system lost heading and this caused incorrect "true wind" to be reported.

On August 27 the Starboard RM Young wind bird started showing widely different wind data. The sensor was covered with rim ice and was not moving as can be seen in the figure below. The Port wind bird was moving in the time window shown below but it's data could be considered suspect in this time frme also. Around mid day on August 29 the Starboard Wind Bird returned to collecting dat without ice interference.

Figure A.1. Wind Bird iced up Wind Speed example

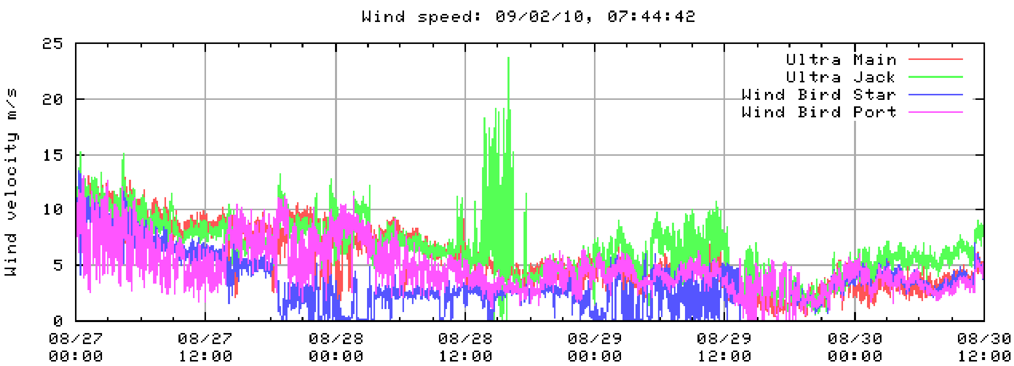
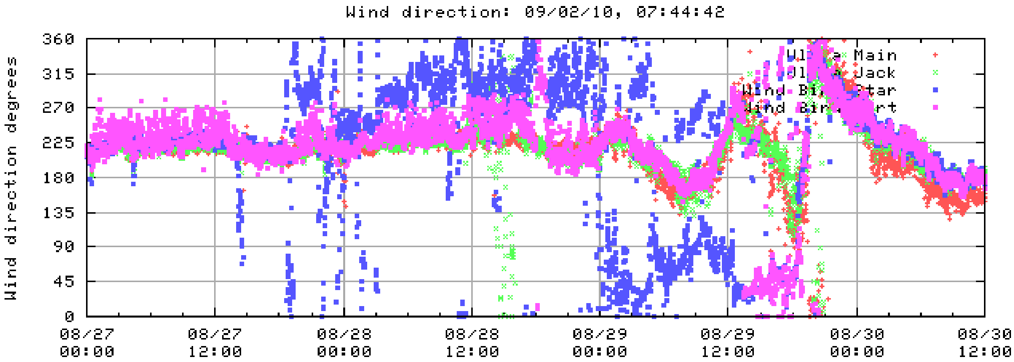
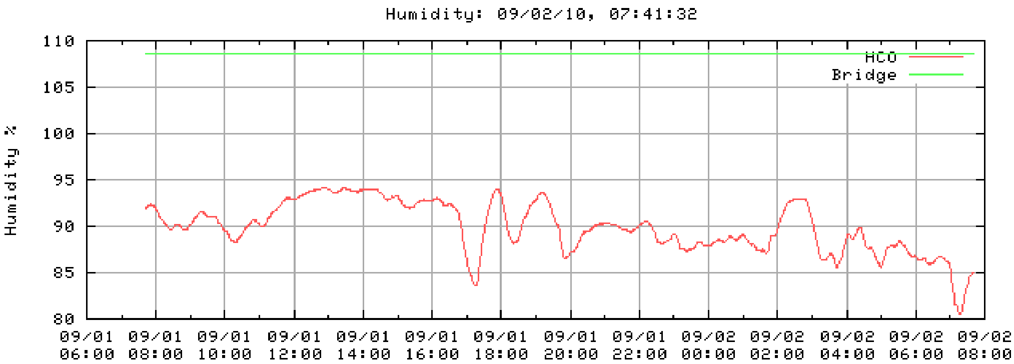


Figure A.2. Wind Bird iced up Wind Direction example



During the cruise the Ship's Bridge Humidity Sensor consistantly had values above 100%. These data should be considered suspect.

Figure A.3. Example of high Bridge Humidity values

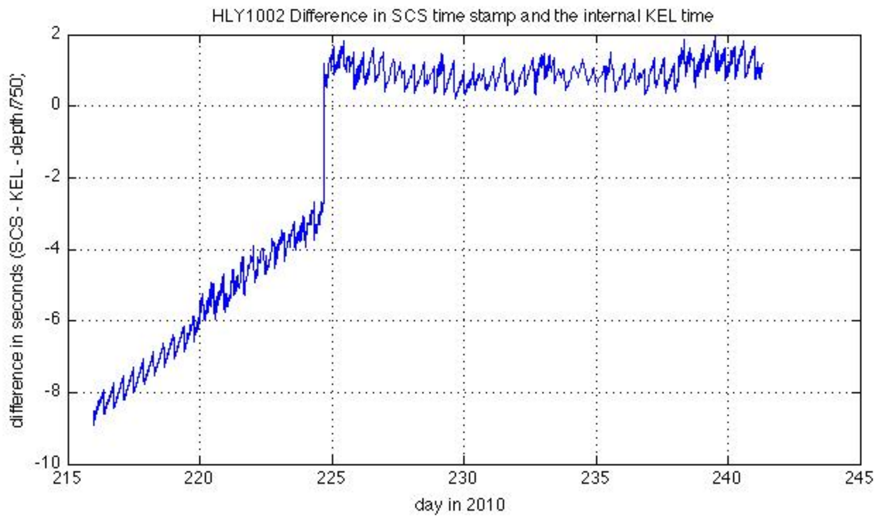


Knudsen Sub Bottom Echo Sounder

The Knudsen ran well during this leg.

Below is an example of the time differences between the SCS time stamp in the KEL file from the Knudsen plotted against the day. The travel time of the ping is assumed to be 1500 m/s and this travel time is removed from the time differences.

Figure A.4. Knudsen KEL data file time shifts



SCS data acquistion

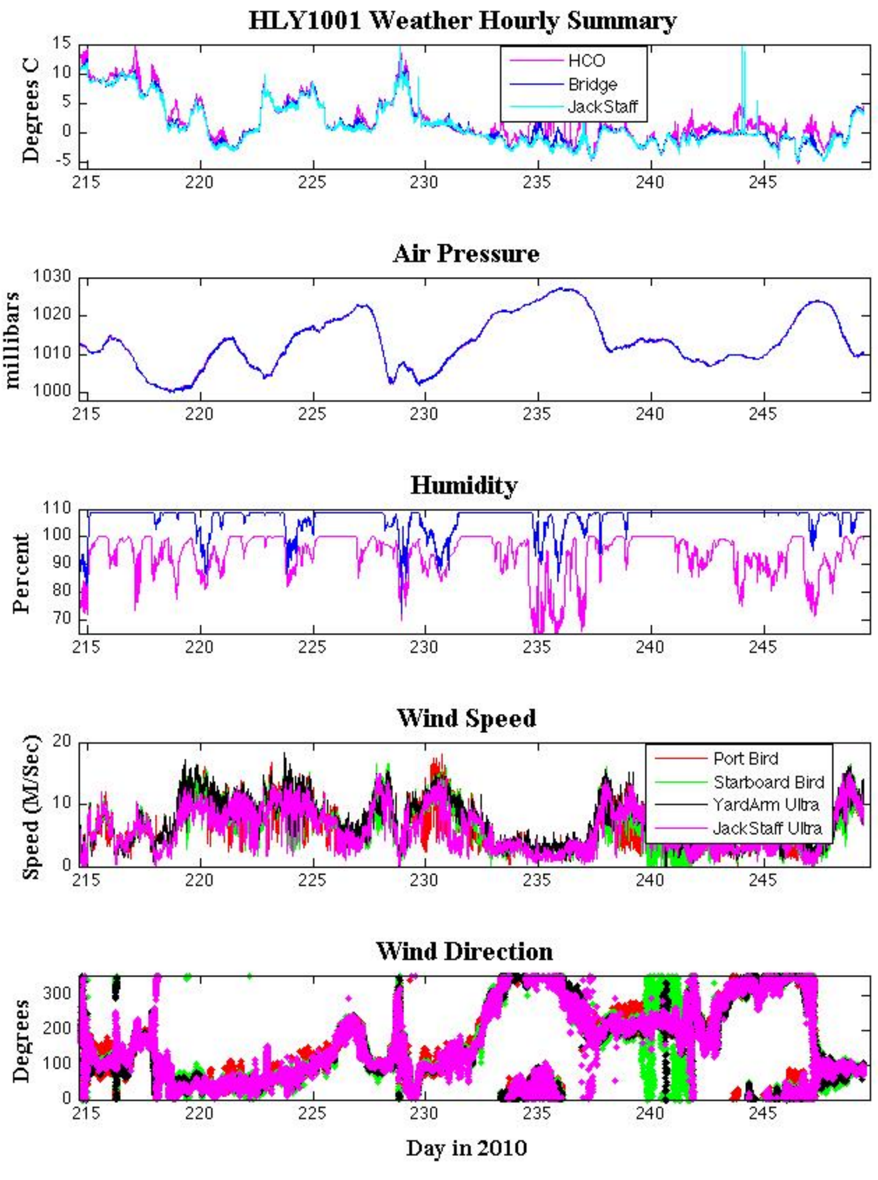
SCS was only stopped for configuration changes a few times during this leg.

Lamont Data System

LDS ran well during this leg.

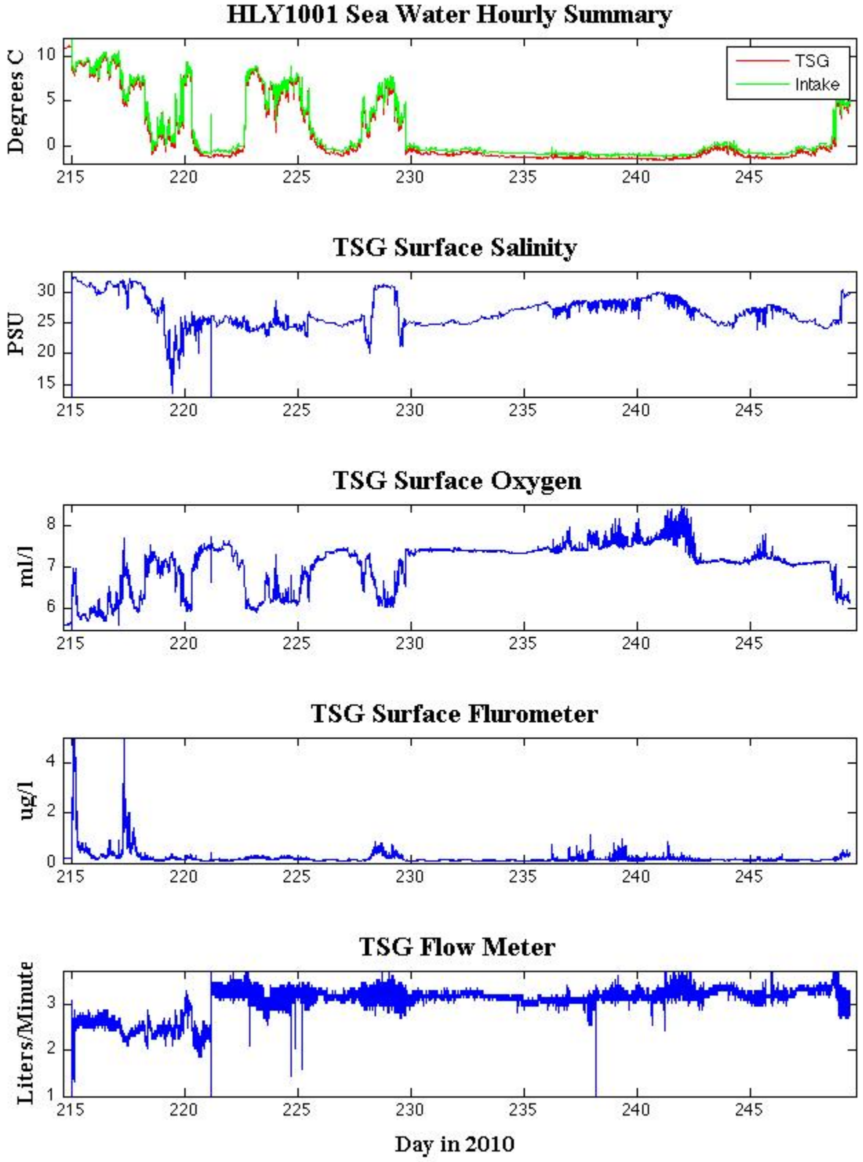
Weather Summary for the Cruise

Figure A.5. Weather Summary for the Cruise



TSG Summary for the Cruise

Figure A.6. TSG Summary for the Cruise



CTD and XBT Stations

These stations were used to create Sound Speed Profiles during the Curent cruise.

CTD Stations

Table A.2. CTD Stations

Station	Date	Time(UTC)	Latitude	Longitude
001	Aug/09/2010	18:31:03	72.484667 N	139.808167 W
002	Aug/12/2010	14:38:33	71.020667 N	144.266833 W
003	Aug/12/2010	17:00:09	71.016667 N	144.253667 W
004	Aug/13/2010	23:47:04	72.840333 N	145.431000 W
005	Aug/20/2010	00:53:00	76.176667 N	155.937500 W
006	Aug/21/2010	15:35:28	76.576667 N	146.319667 W
007	Aug/26/2010	07:05:27	82.531333 N	139.252500 W
008	Aug/27/2010	15:21:54	81.792500 N	128.398167 W
009	Aug/28/2010	01:13:17	81.750500 N	126.919000 W
010	Sep/02/2010	19:55:59	76.539500 N	128.623500 W

XBT Stations

Table A.3. XBT Stations

XBT	File	Date	Time(UTC)	Latitude	N/S	Longitude	E/W	Type	Maxdb
82	T7_00082.EDF	08/03/2010	07:34:25	58.13220	N	167.653190	W	T-7	760
83	T7_00083.EDF	08/05/2010	02:03:13	65.91365	N	168.283301	W	T-7	760
84	T7_00084.EDF	08/06/2010	22:02:31	71.96971	N	153.665365	W	T-7	760
85	T7_00085.EDF	08/07/2010	20:03:40	70.95589	N	144.035514	W	T-7	760
86	T7_00086.EDF	08/08/2010	02:34:52	70.37580	N	140.237760	W	T-7	760
87	T7_00087.EDF	08/09/2010	02:43:51	72.72452	N	137.866976	W	T-7	760
88	T7_00088.EDF	08/13/2010	06:10:08	71.29372	N	146.632129	W	T-7	760
89	T7_00089.EDF	08/13/2010	13:42:36	72.29115	N	145.371305	W	T-7	760
90	T7_00090.EDF	08/14/2010	21:03:31	73.88945	N	145.303450	W	T-7	760
91	T7_00091.EDF	08/15/2010	18:14:14	72.89306	N	148.583724	W	T-7	760
92	T7_00092.EDF	08/15/2010	21:27:15	72.47222	N	149.911344	W	T-7	760
93	T7_00093.EDF	08/16/2010	07:49:31	71.68199	N	155.260449	W	T-7	760
94	T7_00094.EDF	08/16/2010	23:12:33	71.53033	N	156.341911	W	T-7	760
95	T7_00095.EDF	08/17/2010	16:45:42	72.98630	N	151.163607	W	T-7	760
96	T5_00096.EDF	08/17/2010	22:57:11	73.72616	N	150.680859	W	T-5	1830
97	T7_00097.EDF	08/17/2010	23:03:37	73.73437	N	150.674577	W	T-7	760
98	T7_00098.EDF	08/18/2010	20:50:09	75.04239	N	151.352051	W	T-7	760
99	T7_00099.EDF	08/19/2010	19:08:57	75.81798	N	156.135547	W	T-7	760
100	T5_00100.EDF	08/20/2010	19:21:34	76.35354	N	151.770443	W	T-5	1830
101	T7_00101.EDF	08/21/2010	05:20:08	76.47736	N	148.988151	W	T-7	760
102	T7_00102.EDF	08/21/2010	05:33:44	76.48020	N	148.931397	W	T-7	760
103	T7_00103.EDF	08/22/2010	18:53:15	78.33223	N	151.141064	W	T-7	760
104	T5_00104.EDF	08/23/2010	18:52:43	79.00893	N	144.988086	W	T-5	1830

XBT	File	Date	Time(UTC)	Latitude	N/S	Longitude	E/W	Type	Maxdb
105	T5_00105.EDF	08/23/2010	08:58:36	79.00881	N	144.988037	W	T-5	1830
106	T5_00106.EDF	08/24/2010	04:24:56	79.83632	N	140.895215	W	T-5	1830
107	T5_00107.EDF	08/25/2010	09:08:21	81.58965	N	134.396696	W	T-5	1830
108	T5_00108.edf	08/29/2010	00:54:31	80.97926	N	119.093766	W	T-5	1830
109	T7_00109.EDF	08/31/2010	05:12:57	76.85016	N	138.032731	W	T-7	760
110	T5_00110.EDF	09/01/2010	03:29:09	74.81427	N	138.160677	W	T-5	1830
111	T5_00111.EDF	09/01/2010	09:37:38	74.42394	N	131.906104	W	T-5	1830
112	T5_00112.EDF	09/04/2010	02:45:34	76.85129	N	135.677865	W	T-5	1830
113	T7_00113.EDF	09/05/2010	05:09:34	74.94937	N	142.177474	W	T-7	760
114	T7_00114.EDF	09/05/2010	07:08:59	73.33320	N	149.520508	W	T-7	760
115	T5_00115.EDF	09/05/2010	09:29:25	73.07121	N	151.241781	W	T-5	1830

Sensors Used

To see the individual Sensor Calibration Sheets go to the Meta_Data directory on the USB Disk drive. You should use the Sensor's Serial number to be sure you have found the proper sheet.

Shipboard Sensors

Meteorology & Radiometers

Table A.4. Meteorology & Radiometers

Sensor	Description	Serial #	Last Calibration Date	Status
Port Anemometer	RM Young 09101	L001	02/06/07	Collected
Stbd Anemometer	RM Young 09101	L003	03/07/07	Collected
Bridge Air Temperature	RM Young 26700	1643	02/22/08	Collected
Bridge Barometer & Rel. Hum.	RM Young 26700	13352	02/09/10	Collected
HCO PAR	BSI QSR-2200	20270	04/08/09	Collected
HCO Shortwave Radiation	Eppley Labs PSP	35032F3	04/06/10	Collected
HCO Longwave Radiation	Eppley Labs PIR	34955F3	02/04/10	Collected
HCO Barometer, Air Temperature & Rel. Hum,	Paroscientific MET3A	101757	06/27/07	Collected
Jack Staff Air Temperature	RM Young 41342LC	15166	03/20/10	Collected
Jack Staff Ultrasonic Anemometer	RM Young 85004	00894	09/20/07	Collected
Starboard Yard Arm Ultrasonic Anemometer	RM Young 85004	00704	09/20/07	Collected

Underway Ocean Sensors

Table A.5. Underway Ocean Sensors

Sensor	Description	Serial #	Last Calibration Date	Status
TSG	SeaBird SBE45	0228	02/20/10	Collected
SSW Intake Sea Temp	SeaBird SBE3S	4063	02/18/10	Collected
Flowmeter at TSG	Flocat C-ES45B003	09061005	01/07/08	Collected
Fluorometer at TSG	Seapoint SCF	SCF2957	12/15/07	Collected
Oxygen Sensor at TSG	SeaBird SBE-43	431333	09/09/10	Collected
Water Pressure at TSG	Hiller1	001P	01/16/08	Collected

Sonars

Table A.6. Sonars

Sensor	Description	Serial #	Last Calibration Date	Status
Knudsen - subbottom	320 B/R	K2K-00-0013	N/A	Collected
RDI OS150 ADCP	Ocean Sureyor	80	N/A	Collected
RDI OS75 ADCP	Ocean Sureyor	172	N/A	Collected
Multibeam	EM122 1º x 2º	106	N/A	Collected

Navigation

Table A.7. Navigation

Sensor	Description	Serial #	Last Calibration Date	Status
P-Code GPS (aft)	Trimble Centurion	0220035469	N/A	Collected
3D GPS	Thales (Ashtech) ADU5	AD520033513	N/A	Collected
DGPS	Trimble AG132	0224016199	N/A	Collected
POS/MV-320	Version 4 Single Frequency (L1)	2306	May 2010	Collected
POS/MV-320	Version 4 Dual Frequency (L1,L2)			Not Collected
P-Code GPS (fwd)	Rockwell	?	N/A	Collected
GYRO 1	Sperry MK39 PN 03956-1982416-2	340	?	Collected
GYRO 2	Sperry MK27A 4800880-1	025	N/A	Collected

CTD Sensors from HLY1002

CTD Sensors in 12 Bottle Rossette Configuration

Table A.8. CTD Sensors in 12 Bottle Rossette Configuration

Sensor	Comments	Serial #	Last service/ Calibration Date	Status
CTD fish	SBE 911plus	638		
Pressure Sensor #1	Digiquartz with TC	083009	02/26/10	Collected
Temperature #1	SBE3- Primary	2945	02/17/10	Collected
Temperature #2	SBE3- Secondary	2824	02/18/10	Collected
Conductivity #1	SBE4- Primary	2545	02/18/10	Collected
Conductivity #2	SBE4- Secondary	2575	02/18/10	Collected
Pump	SBE5 Primary	53115		
Pump	SBE5 Secondary	53114		
Deck Unit	SBE 11-Plus 2	417		
Altimeter	PSA-916		01/10	Collected
PAR	Bioshperical QSP2200	70112	05/28/10	Collected
Carousel	SBE32- 12 place			

CTD Sensors in 24 Bottle Rossette Configuration

Table A.9. CTD Sensors in 24 Bottle Rossette Configuration

Sensor	Comments	Serial #	Last service/ Calibration Date	Status
CTD fish	SBE 911plus	639		
Pressure Sensor #1	Digiquartz with TC	83012	03/26/10	Collected
Temperature #1	SBE3- Primary	2841	02/18/10	Collected
Temperature #2	SBE3- Secondary	2855	02/16/10	Collected
Conductiity #1	SBE4- Primary	2568	02/18/10	Collected
Conductiity #2	SBE4- Secondary	2561	03/18/10	Collected
Pump	SBE5 Primary	53113		
Pump	SBE5 Secondary	53112		
Deck Unit	SBE 11-Plus 2	417		
Altimeter	PSA-916		01/10	Collected
Oxygen	SBE43	456	03/05/10	Collected
Fluorometer	Chelsea-Aqua3	088234	02/12/10	Collected
Carousel	SBE32- 24 place			

Software Versions of some data of the acquisition and control software

This section correctly reflects information about some of the key software packages used during this cruise.

Table A.10. Software Versions of some data of the acquisition and control software

System	Program	Version number
CTD	Seabird SeaSave	7.20f
XBT	Turo XBT software (not used during this cruise)	3.03.01
XBT	Sippican MK21	2.1.2
ADCP 75	VMDAS (not used during this cruise)	1.46
ADCP 150	VMDAS (not used during this cruise)	1.46
ADCPs	UHDAS	June 2010 Version
POS/MVs	MV-Posview	5.1.0.2
EM122	SIS	3.7 Beta Build 90 DBVersion 18.0
NOAA SCS Acquistion	SCS	4.2
SIO Met/TSG	MetAcq	2.04e
Terascan/WDS	WDS	
Lamont Data System	LDS	May 2010

Calibration Sheets
Meteorology & Radiometer Sensors
Yard Arm R.M. Young Wind Bird, Starboard

R. M. Young Wind bird Calibration Results
Model # 09101, S/N L001 (Port Windbird)
As per Young Meteorological Instruments
Wind System Calibration Manual

Date: 06 Feb 07 Technician: ET3 Daem / ET2 Davis

`

Wind speed torque: Passed

Maximum toque =2.40 gm/cm

Test results:
CW .2 gm/cm
CCW .2 gm/cm

Wind direction torque: Passed

Maximum toque = 30 gm/cm

Test results:
CW 10gm/cm
CCW 10gm/cm

Wind speed signal: Passed

Maximum % error = 1%

Test results:

Actual RPM	Actual Wind Speed	Measured	% Error
200	1.90	1.9	0.21
500	4.76	4.8	0.84
1200	11.42	11.4	0.21
3600	34.27	34.3	0.08
5000	47.60	47.6	0.00

Note; Wind speed in knots = 0.00952 * shaft RPM

Wind direction signal: Passed

Maximum error = +/- 2 degrees
Test results:

Actual	Meaured	Error
0	359	-1
30	29	1
60	59	1
90	90	0
120	120	0
150	150	0
180	180	0
210	210	0
240	240	0
270	269	1
300	298	2
330	330	0

Yard Arm R.M. Young Wind Bird Port

R. M. Young Wind bird Calibration Results
Model # 09101, S/N L003 (Starboard Windbird)
As per Young Meteorological Instruments
Wind System Calibration Manual

Date: 07 Mar 07 Technician: ET1 Berringer / ETC Rodda

Wind speed torque: Passed

Maximum toque = 2.4 gm/cm
Test results:

CW	0.7
CCW	0.7

Wind direction torque: Passed

Maximum toque = 30 gm/cm

Test results:

CW	20 gm/cm
CCW	22 gm/cm

Wind speed signal:

Maximum % error = 1%

Test results: Passed

Actual RPM	Actual Wind Speed	Measured	% Error
200	1.90	1.9	0.21
500	4.76	4.8	0.84
1200	11.42	11.4	0.21
3600	34.27	34.3	0.08
5000	47.60	47.6	0.00

Note; Wind speed in knots = 0.00952 * shaft RPM

Wind direction signal:

Maximum error = +/- 2 degrees

Test results: Failed – off by 1 degree

Actual	Meaured	Error
0	358	-2
30	27	3
60	58	2
90	88	2
120	118	2
150	149	1
180	178	2
210	207	3
240	238	2
270	268	2
300	297	3
330	327	3

Bridge Barometer

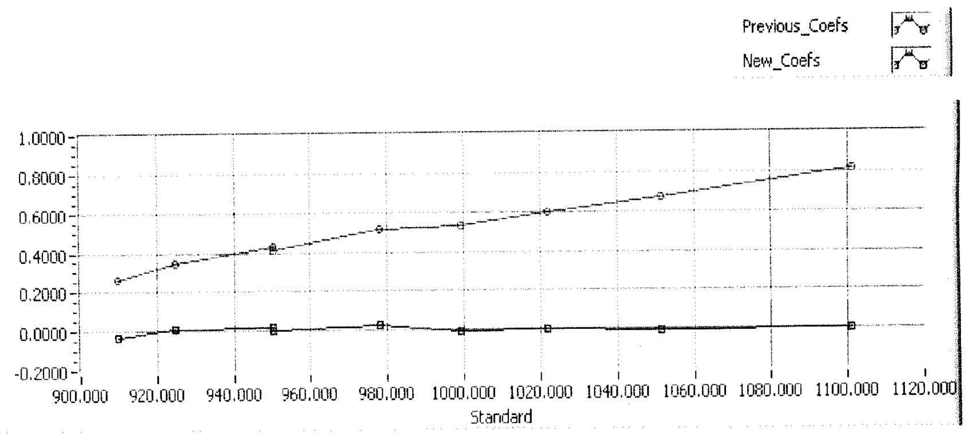
Barometric Pressure Calibration Report
STS/ODF Calibration Facility

SENSOR SERIAL NUMBER: 01643
CALIBRATION DATE: 24-Dec-08
SENSOR ID: BPR30
Mfg: RM Young Model: 61201
Previous Cal Date: 26-Feb-2008
Calibration Tech: CM

A= 5.99743E-2
B= 8.03054E+2

Calibration Standard: Mfg: Weston Model: DPM7885-1A s/n: 100056
Polynomial Order = 1
Xcalc = A*X+B

SENSOR	STANDARD DATA	SENSOR New_Coefs	SPRT-INST Prev_Coefs	SPRT-INST New_Coefs
4965.600	1100.861	1100.863	0.816	-0.002
4139.040	1051.280	1051.290	0.672	-0.010
3646.720	1021.762	1021.764	0.601	-0.002
3272.144	999.289	999.299	0.531	-0.010
2919.472	978.174	978.148	0.510	0.026
2458.104	950.480	950.477	0.411	0.003
2458.240	950.508	950.486	0.431	0.022
2030.400	924.833	924.826	0.346	0.007
1782.560	909.928	909.962	0.265	-0.034



Bridge Air Temperture / Relative Humidity

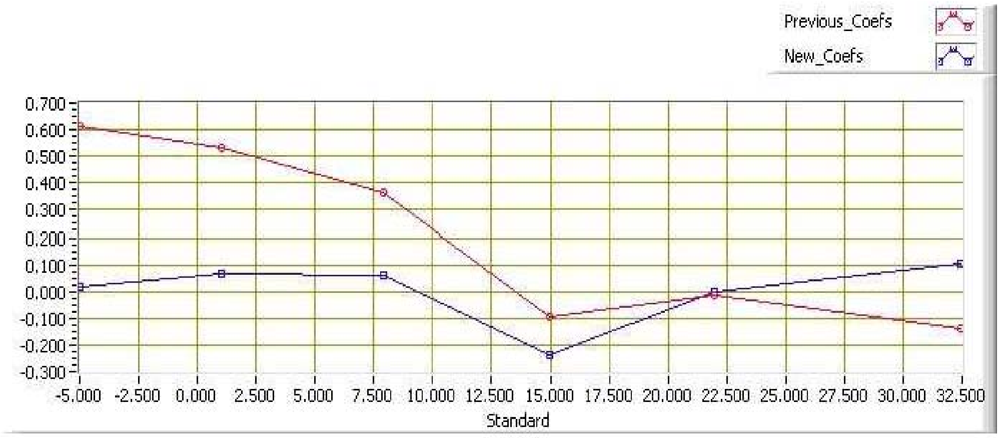
Air Temperature Calibration Report
STS/ODF Calibration Facility

SENSOR SERIAL NUMBER: 13352
CALIBRATION DATE: 9-FEB-2010
SENSOR ID: HRH19
Mfg: RM Young **Model:** 41382V
Previous Cal Date: 24-Oct-2007
Calibration Tech: CM

A= 9.78153505E+1
B= -4.84350199E+1

Calibration Standard: Mfg: Seabird Model: SBE35 s/n: 0006
Polynomial Order = 1
Xcalc = A*X+B

SENSOR	STANDARD DATA	SENSOR New_Coefs	SPRT-INST Prev_Coefs	SPRT-INST New_Coefs
0.4439	-5.0000	-5.0148	0.6100	0.0148
0.5047	1.0000	0.9324	0.5300	0.0676
0.5755	7.9168	7.8577	0.3668	0.0591
0.6509	14.9942	15.2330	-0.0958	-0.2388
0.7201	21.9983	22.0018	-0.0117	-0.0035
0.8259	32.4515	32.3507	-0.1385	0.1008



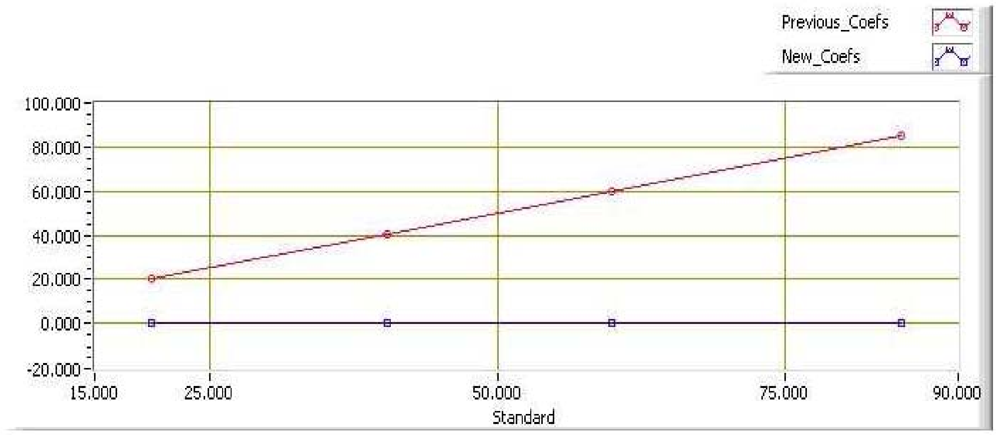
HUMIDITY Calibration Report
STS/ODF Calibration Facility

SENSOR SERIAL NUMBER: 13352
CALIBRATION DATE: 11-FEB-2010
SENSOR ID: HRH31
Mfg: RM Young Model: 41382V
Previous Cal Date: 01-Nov-2009
Calibration Tech: CM

A= 2.73058225E+1
B= 7.76410061E+1
C= 3.86418175E+0

Calibration Standard: Mfg: GE Sensing Model: Humilab s/n: 0240507
Polynomial Order = 2
Xcalc = A*X^2+B*X+C

SENSOR	STANDARD DATA	SENSOR New_Coefs	SPRT-INST Prev_Coefs	SPRT-INST New_Coefs
0.1930	19.9039	19.8660	19.8846	0.0379
0.4120	40.3587	40.4873	40.3175	-0.1286
0.5950	59.8561	59.7275	59.7966	0.1286
0.8140	85.1188	85.1567	85.0374	-0.0379



HCO PAR

Biospherical Instruments Inc.

CALIBRATION CERTIFICATE

Calibration Date	4/8/2010
Model Number	QSR2200
Serial Number	20270
Operator	TPC
Standard Lamp	GS-1019(8/28/08)
Probe Excitation Voltage Range:	6 to 18 VDC(+)
Output Polarity:	Positive

Probe Conditions at Calibration(in air):

Calibration Voltage:	6	VDC(+)
Probe Current:	4.0	mA

Probe Output Voltage:

Probe Illuminated	88.5	mV
Probe Dark	1.3	mV
Probe Net Response	87.1	mV
RG780	1.9	mV

Corrected Lamp Output:

Output In Air (same condition as calibration):

9.088E+15 quanta/cm^2sec

0.01509 uE/cm^2sec

Calibration Scale Factor:

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

Dry: 9.5883E-18 V/(quanta/cm^2sec)

5.7740E+00 V/(uE/cm^2sec)

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

HCO Shortwave Radiation Pyranometer PSP

This is an old Calibration Sheet from 11/11/08, since the current PDF calibration file is not readable.

THE EPPLEY LABORATORY, INC.
12 Sheffield Ave., P.O. Box 419, Newport, RI 02840 USA
Telephone: 401-847-1020 Fax: 401-847-1031
Email: info@eppleylab.com Internet: www.eppleylab.com

EPLAB
Scientific Instruments
for Precision Measurements
Since 1917

STANDARDIZATION OF EPPLEY PRECISION SPECTRAL PYRANOMETER Model PSP

Serial Number: 35032F3

Resistance: 724 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 conatant).

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

8.20 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 Tenth International Pyrheliometric Comparisons (IPC X) at Davos, Switzerland in September-October 2005.

Eppley recommends a minimum calibration cycle of five (5) years but encourages annual calibrations for highest measurement accuracy. Unless otherwise stated in the remarks section below or on the Sales Order, the results are "AS FOUND / AS LEFT".

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

Shipped to:

University of California
La Jolla, CA

S.O. Number: 61853
Date: Nov. 14, 2008

Date of Test: Nov. 11, 2008

In Charge of Test: R.T. Egan

Reviewed by: Thomas D. Kirk

HCO Longwave Radiation Pyrgeometer PIR

EPLAB

THE EPPLEY LABORATORY, INC.

12 Sheffield Avenue, PO Box 419, Newport, Rhode Island USA 02840
Phone: 401.847.1020 Fax: 401.847.1031 Email: info@eppleylab.com

STANDARDIZATION OF
EPPLEY PRECISION INFRARED RADIOMETER
Model PIR

Serial Number: 34955F3

Resistance: 686 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:

3.25×10^{-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 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.

Eppley recommends a minimum calibration cycle of five (5) years but encourages annual calibrations for highest measurement accuracy. Unless otherwise stated in the remarks section below or on the Sales Order, the results are "AS FOUND / AS LEFT".

Shipped to: UCSD-Scripps
La Jolla, CA

S.O. Number: 62386
Date: February 8, 2010

Remarks:

Date of Test: February 4, 2010

In Charge of Test: Debra L. Genty

Reviewed by: Thomas D. Kirk

HCO MET3A Station

This is an old Calibration Sheet since there is no current PDF file.

Paroscientific, Inc.
Pressure Instrument Configuration

SN: 101757 Part Number: 1539-004 Model: MET3A Port:

Calibration Date: 27-Jun-07 Report No: 7238 Technician: WMR

Pressure Range: 500 to 1100 hPa Temperature Range: -50 to +60

Customer: Scripps Inst. of Oceanography Report Date: 27-Jun-07
Address : 8825 Biological Grade Sales Order: 24387
La Jolla, CA 92037 USA S/R Number :

Configuration		Calibration Coefficients	
BL: 0	PT: N	U0:	5.766908 µsec
BR: 9600	QD: -	Y1:	-4015.975 deg C / µsec
DD: -	QO: -	Y2:	-17065.37 deg C / µsec²
DL: -	SL: -	Y3:	-140256.4 deg C / µsec³
DM: -	SN: 101757	C1:	94.87589 psi
DO: -	ST: -	C2:	3.545282 psi / µsec
DP: -	SU: -	C3:	-114.9551 psi / µsec²
ID: 01	TI: -	D1:	0.0345157
IM: -	TR: 00952	D2:	0.0000000
LL: -	TU: -	T1:	28.00064 µsec
LH: -	UF: 1.000000	T2:	0.837535 µsec / µsec
MC: Y	UL: -	T3:	16.78157 µsec / µsec²
MD: 0	UM: -	T4:	-150.7085 µsec / µsec³
MN: -	UN: 3	T5:	-129.729 µsec / µsec⁴
OP: -	US: -	TC:	0.6782145
PF: -	VR: M1.02	PA:	0.0000000
PI: -	ZI: -	PM:	1.0000000
PL: -	ZS: -		
PO: -	ZL: -		
PR: 00238	ZV: -		
PS: -			

Met3/3A Coefficients	
E1: -0.551136	E2: 0.84
F1: -264.3591	F2: 3.152
G1: 12.56743	G2: 0.00216
H1: RHT894	H2: 0.0036
K1: 01842	K2: 0.00511
M1: 1	M2: 1
Z1: 0	Z2: 0

Paroscientific, Inc.
4500 148th Ave. N.E. Redmond, WA 98052
Phone: (425)883-8700 Fax: (425)867-5407
Web:http://www.paroscientific.com
Email: support@paroscientific.com

Prepared by

PARO TEST 17

Digiquartz® Technology

Page 1 of 1

Paroscientific, Inc.
4500 148th Avenue N. E.
Redmond, WA 98052-5194
Telephone: (425) 883-8700
Facsimile: (425) 867-5407
Email:salessupport@paroscientific.com
Internet:http://www.paroscientific.com

CERTIFICATE OF CALIBRATION

TRANSDUCER MODEL: MET3A

SERIAL NUMBER: 101757

The Paroscientific transducer(s) identified above has been calibrated and tested with one or more of the following primary pressure and temperature standards. All have traceability to the National Institute of Standards and Technology.

Bell and Howell Primary Pressure Standard

Pneumatic Absolute or Gauge Dead Weight Tester Part Number: 6-201-0001, S/N 4034 and S/N 1014

___ Piston/Cylinder: 6-001-0002, P2-919/C2-1523,
Weight Set 1: 6-002-0002
Range: 1.5 to 50 psi [10 to 345 kPa]
Accuracy: 0.010 percent of reading

✓ Piston/Cylinder: 6-001-0002, P2-652/C2-1378,
Weight Set 2: 6-002-0002
Range: 1.5 to 50 psi [10 to 345 kPa]
Accuracy: 0.010 percent of reading

___ Piston/Cylinder: 6-001-0001, P1-949/C1-922 ,
Weight Set 2: 6-002-0002
Range: 0.3 to 5 psi [2 to 34 kPa]
Accuracy: 0.015 percent of reading

DH Primary Pressure Standard

Pneumatic Absolute or Gauge Dead Weight Tester Part Number: PG7601 S/N 161

___ Piston/Cylinder: S/N 305, Mass Set: S/N 2052
Range: 0.7 to 50 psi [5 to 345 kPa] absolute mode, 0.29 to 50 psi [2 to 345 kPa] gauge mode
Accuracy: 0.002 percent of reading

DH Primary Pressure Standard

Pneumatic Gauge Dead Weight Tester, Model 5203, S/N 5557

___ Piston/Cylinder: S/N 4845, Mass Sets: S/N 2032, S/N 3293
Range: 20 to 1,600 psi [0.14 to 11 MPa]
Accuracy: 0.005 percent of reading

DH Primary Pressure Standard

Oil Operated Gauge Dead Weight Tester, Model 5306, S/N 3505

___ Piston/Cylinder: S/N 3375, Mass Set: S/N 2032
Range: 40 to 20,000 psi [0.3 to 138 MPa]
Accuracy: 0.01 percent of reading above 200 psi [1.4 MPa]
or 0.02 psi [0.14 kPa] at lower pressure

___ Piston/Cylinder: S/N 3511, Mass Set: S/N 2032
Range: 145 to 72,500 psi [1 to 500 MPa]
Accuracy: 0.02 percent of reading above 725 psi [5 MPa]
or 0.145 psi [1 kPa] at lower pressure

Hart Scientific Precision Thermometer (MET3A only)

✓ Black Stack model 1560 S/N 97568, PRT Scanner model 2562 S/N A34523, Temperature Probe Model A1959: S/Ns 4424A-02, 4424A-04, 4424A-05, 4424A-06 and 5177C-02.
Range: -50° to 60° C.
Accuracy: .015°C.

PARO TEST 17

Tested By: ______ DATE 6-27-07

Digiquartz® Pressure Instrumentation
Document No. 8145-001, Rev. M 4/18/07

Jack Staff Air Temperature

No Calibration Sheet is available.

Jack Staff Ultrasonic Anemometer

No Calibration Sheet is available.

Starboard Yard Arm Ultrasonic Anemometer

No Calibration Sheet is available.

Underway Ocean Flow through Sensors

TSG

Conductivity

SEA-BIRD ELECTRONICS, INC.
13431 NE 20th Street, Bellevue, Washington, 98005-2010 USA
Phone: (425) 643 - 9866 Fax (425) 643 - 9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 0228
CALIBRATION DATE: 20-Feb-10

SBE 45 CONDUCTIVITY CALIBRATION DATA
PSS 1978: C(35,15,0) = 4.2914 Siemens/meter

COEFFICIENTS:

g = -9.992728e-001
h = 1.527200e-001
i = -3.825513e-004
j = 5.529366e-005

CPcor = -9.5700e-008
CTcor = 3.2500e-006
WBOTC = 6.5023e-007

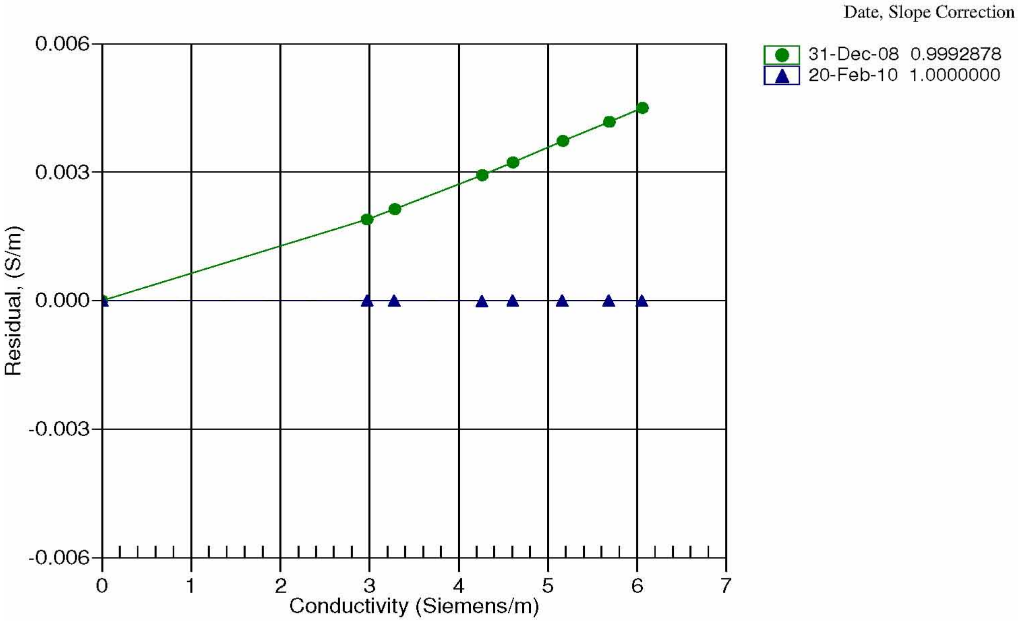
BATH TEMP (ITS-90)	BATH SAL (PSU)	BATH COND (Siemens/m)	INST FREQ (Hz)	INST COND (Siemens/m)	RESIDUAL (Siemens/m)
22.0000	0.0000	0.00000	2563.13	0.00000	0.00000
1.0000	34.7504	2.97087	5107.22	2.97087	0.00000
4.5000	34.7304	3.27742	5300.09	3.27742	-0.00000
15.0000	34.6871	4.25744	5873.52	4.25743	-0.00001
18.5000	34.6776	4.60195	6061.92	4.60195	0.00000
24.0000	34.6643	5.15851	6354.15	5.15851	0.00000
29.0000	34.6564	5.67907	6615.42	5.67907	0.00000
32.5000	34.6511	6.05043	6795.45	6.05043	-0.00000

f = INST FREQ * sqrt(1.0 + WBOTC * t) / 1000.0

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

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

Residual = instrument conductivity - bath conductivity



Temperature

SEA-BIRD ELECTRONICS, INC.
13431 NE 20th Street, Bellevue, Washington, 98005-2010 USA
Phone: (425) 643 - 9866 Fax (425) 643 - 9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 0228
CALIBRATION DATE: 20-Feb-10

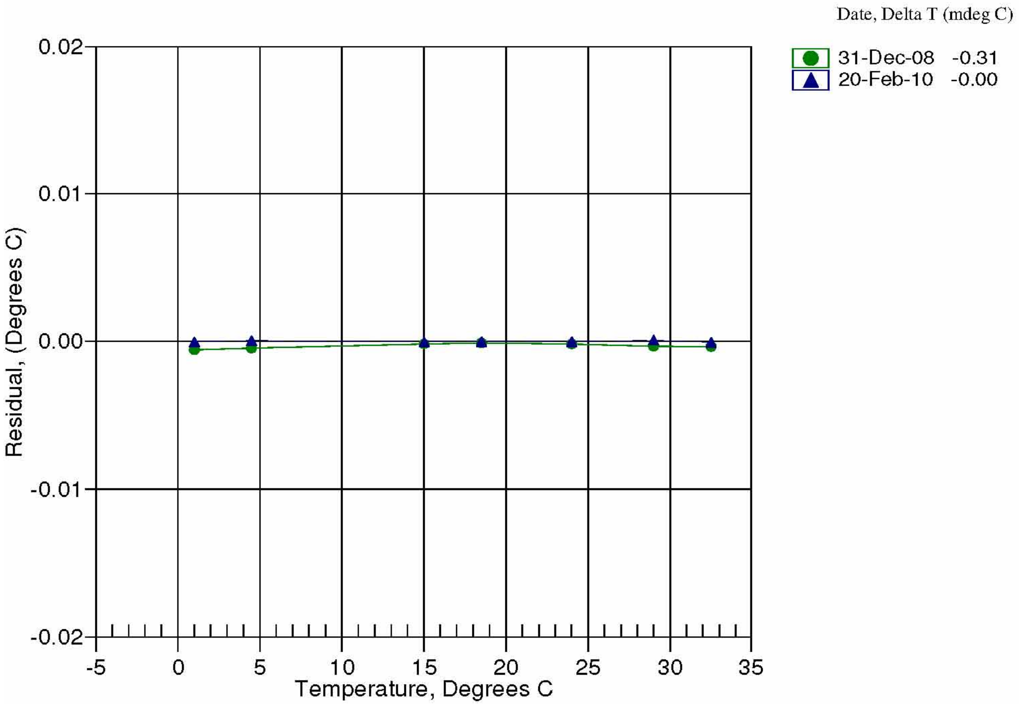
SBE 45 TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

ITS-90 COEFFICIENTS
a0 = -5.607671e-005
a1 = 2.871294e-004
a2 = -3.326111e-006
a3 = 1.764878e-007

BATH TEMP (ITS-90)	INSTRUMENT OUTPUT	INST TEMP (ITS-90)	RESIDUAL (ITS-90)
1.0000	727992.2	1.0000	-0.0000
4.5000	622326.9	4.5001	0.0001
15.0000	396397.5	15.0000	-0.0000
18.5000	343173.4	18.5000	-0.0000
24.0000	275221.7	24.0000	-0.0000
29.0000	226561.4	29.0001	0.0001
32.5000	198369.3	32.4999	-0.0001

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

Residual = instrument temperature - bath temperature



UCW Intake Sea Temp

SEA-BIRD ELECTRONICS, INC.
13431 NE 20th Street, Bellevue, Washington, 98005-2010 USA
Phone: (425) 643 - 9866 Fax (425) 643 - 9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 4063
CALIBRATION DATE: 18-Feb-10

SBE3 TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

ITS-90 COEFFICIENTS
g = 4.29925261e-003
h = 6.36458146e-004
i = 2.07205402e-005
j = 1.52667979e-006
f0 = 1000.0

IPTS-68 COEFFICIENTS
a = 3.68121241e-003
b = 5.99700546e-004
c = 1.61619410e-005
d = 1.52813233e-006
f0 = 2721.824

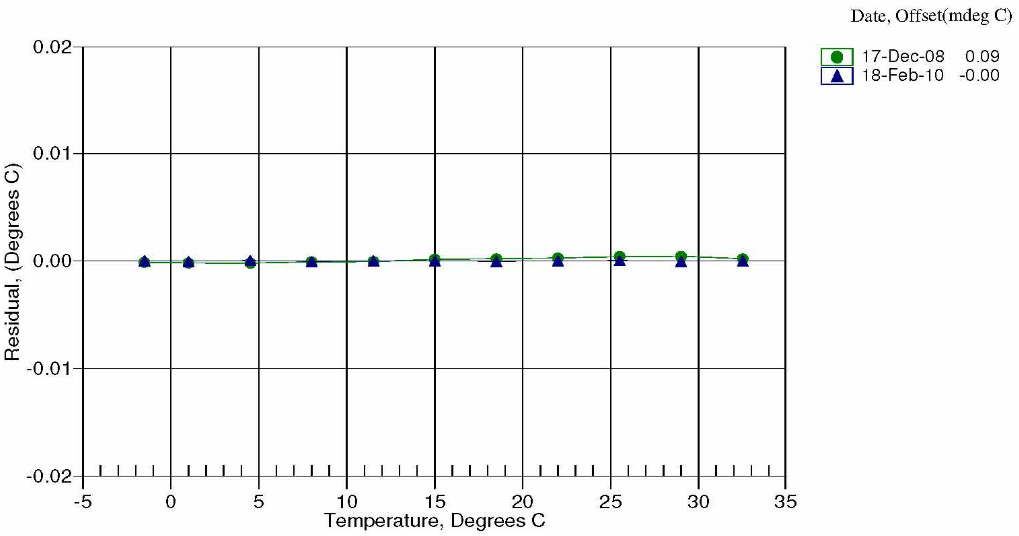
BATH TEMP (ITS-90)	INSTRUMENT FREQ (Hz)	INST TEMP (ITS-90)	RESIDUAL (ITS-90)
-1.5000	2721.824	-1.5000	-0.00001
1.0000	2878.809	1.0000	-0.00001
4.5000	3109.486	4.5000	0.00005
8.0000	3353.202	8.0000	-0.00003
11.5000	3610.342	11.5000	-0.00000
15.0000	3881.258	15.0000	0.00000
18.5000	4166.300	18.5000	-0.00003
22.0000	4465.822	22.0000	0.00001
25.5000	4780.151	25.5000	0.00004
29.0000	5109.605	29.0000	-0.00001
32.5000	5454.511	32.5000	-0.00001

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

Temperature 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



Flowmeter at TSG

A calibration sheet could not be found.

Fluorometer at TSG

A calibration sheet could not be found.

Oxygen Sensor at TSG

SEA-BIRD ELECTRONICS, INC.
13431 NE 20th Street, Bellevue, Washington, 98005-2010 USA
Phone: (425) 643 - 9866 Fax (425) 643 - 9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 1333
CALIBRATION DATE: 09-Mar-10p

SBE 43 OXYGEN CALIBRATION DATA

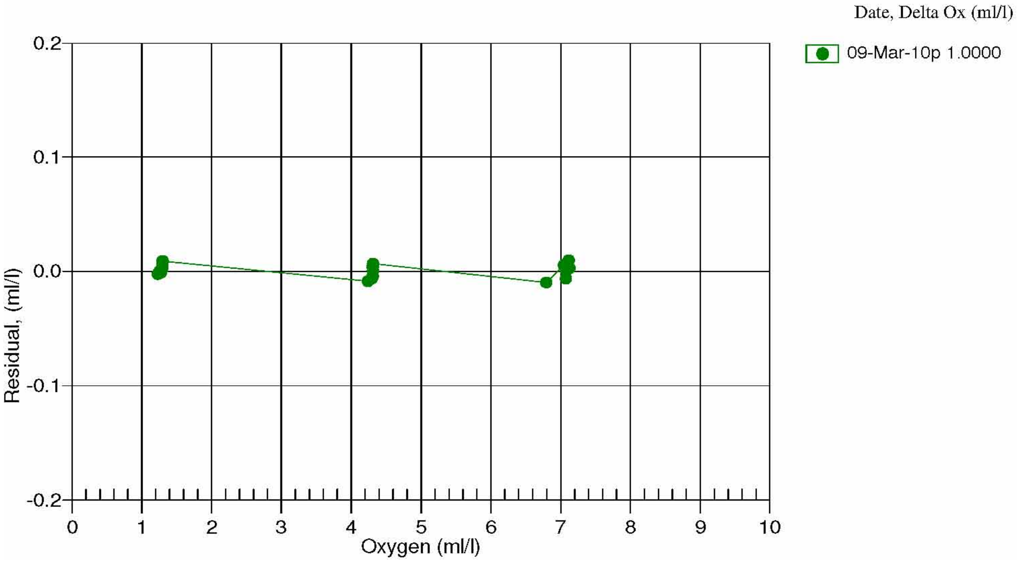
COEFFICIENTS
Soc = 0.4743
Voffset = -0.5044
Tau20 = 1.32

A = -2.2078e-003
B = 1.2595e-004
C = -2.1603e-006
E nominal = 0.036

NOMINAL DYNAMIC COEFFICIENTS
D1 = 1.92634e-4
D2 = -4.64803e-2
H1 = -3.30000e-2
H2 = 5.00000e+3
H3 = 1.45000e+3

BATH OX (ml/l)	BATH TEMP ITS-90	BATH SAL PSU	INSTRUMENT OUTPUT(VOLTS)	INSTRUMENT OXYGEN(ml/l)	RESIDUAL (ml/l)
1.23	2.00	0.00	0.773	1.23	-0.00
1.26	6.00	0.01	0.812	1.26	0.00
1.28	12.00	0.01	0.865	1.27	-0.00
1.29	20.00	0.01	0.938	1.29	0.00
1.30	26.00	0.01	0.993	1.30	0.01
1.30	30.00	0.01	1.032	1.31	0.01
4.24	2.00	0.00	1.429	4.23	-0.01
4.29	6.00	0.01	1.552	4.29	-0.01
4.31	12.00	0.01	1.723	4.31	-0.00
4.31	26.00	0.01	2.124	4.31	0.00
4.31	20.00	0.01	1.950	4.31	0.00
4.31	30.00	0.01	2.247	4.32	0.01
6.79	30.00	0.01	3.240	6.78	-0.01
7.04	26.00	0.01	3.150	7.05	0.01
7.07	20.00	0.01	2.873	7.07	-0.01
7.08	12.00	0.01	2.508	7.08	0.00
7.12	6.00	0.01	2.245	7.13	0.01
7.12	2.00	0.00	2.064	7.13	0.00

Oxygen (ml/l) = Soc * (V + Voffset) * (1.0 + A * T + B * T^2 + C * T^3) * OxSol(T,S) * exp(E * P / K)
V = voltage output from SBE43, T = temperature [deg C], S = salinity [PSU] K = temperature [deg K]
OxSol(T,S) = oxygen saturation [ml/l], P = pressure [dbar], Residual = instrument oxygen - bath oxygen



Water Pressure at TSG

A calibration sheet could not be found.

CTD

12 Bottle Rossette

Pressure Sensor #1

SEA-BIRD ELECTRONICS, INC.

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

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

SENSOR SERIAL NUMBER: 0638
CALIBRATION DATE: 26-Feb-10

SBE9plus PRESSURE CALIBRATION DATA
10000 psia S/N 83009

DIGIQUARTZ COEFFICIENTS:

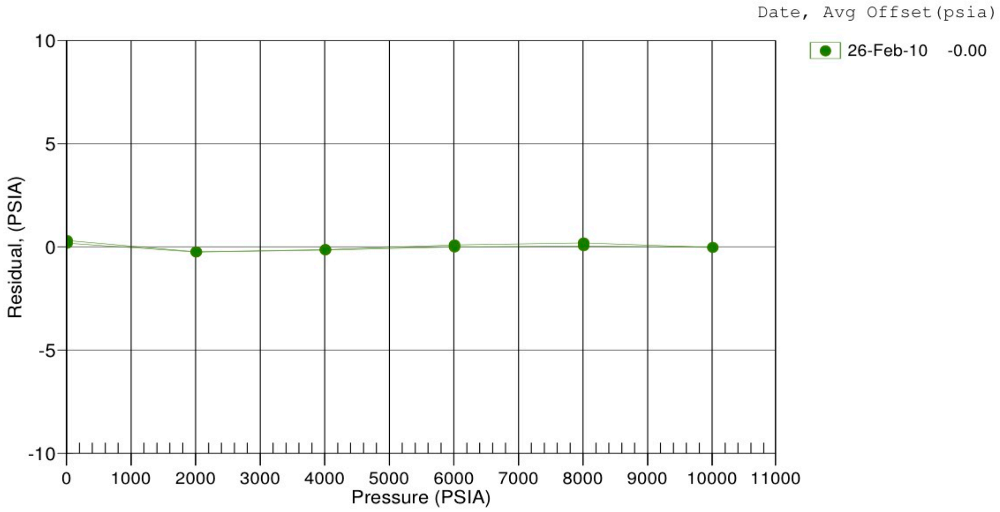
C1 = -4.129335e+004
C2 = -2.366132e-001
C3 = 1.120910e-002
D1 = 3.246900e-002
D2 = 0.000000e+000
T1 = 3.014179e+001
T2 = -1.666793e-004
T3 = 3.283910e-006
T4 = 5.609600e-009
T5 = 0.000000e+000

AD590M, AD590B, SLOPE AND OFFSET:

AD590M = 1.27959e-002
AD590B = -9.20630e+000
Slope = 0.99958
Offset = -0.6528 (dbars)

PRESSURE (PSIA)	INST OUTPUT(Hz)	INST TEMP(C)	INST OUTPUT (PSIA)	CORRECTED INST OUTPUT (PSIA)	RESIDUAL (PSIA)
14.438	33185.02	20.4	15.689	14.742	0.304
2014.838	33977.88	20.5	2016.378	2014.595	-0.243
4014.800	34750.34	20.5	4017.280	4014.662	-0.138
6014.848	35503.83	22.5	6018.392	6014.940	0.092
8014.855	36239.29	22.5	8019.334	8015.046	0.191
10014.926	36957.84	22.5	10020.019	10014.896	-0.030
8014.657	36239.16	22.5	8018.988	8014.700	0.043
6014.611	35503.71	22.6	6018.061	6014.609	-0.002
4014.615	34750.33	22.6	4017.081	4014.464	-0.151
2014.654	33977.86	22.6	2016.187	2014.405	-0.249
14.450	33185.02	22.6	15.575	14.628	0.177

Residual = corrected instrument pressure - reference pressure



Temperature Sensor # 1

SEA-BIRD ELECTRONICS, INC.
13431 NE 20th Street, Bellevue, Washington, 98005-2010 USA
Phone: (425) 643 - 9866 Fax (425) 643 - 9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 2945
CALIBRATION DATE: 17-Feb-10

SBE3 TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

ITS-90 COEFFICIENTS
g = 4.36627333e-003
h = 6.46205579e-004
i = 2.34272116e-005
j = 2.22900920e-006
f0 = 1000.0

IPTS-68 COEFFICIENTS
a = 3.68121213e-003
b = 6.02923529e-004
c = 1.61033096e-005
d = 2.23056029e-006
f0 = 3002.273

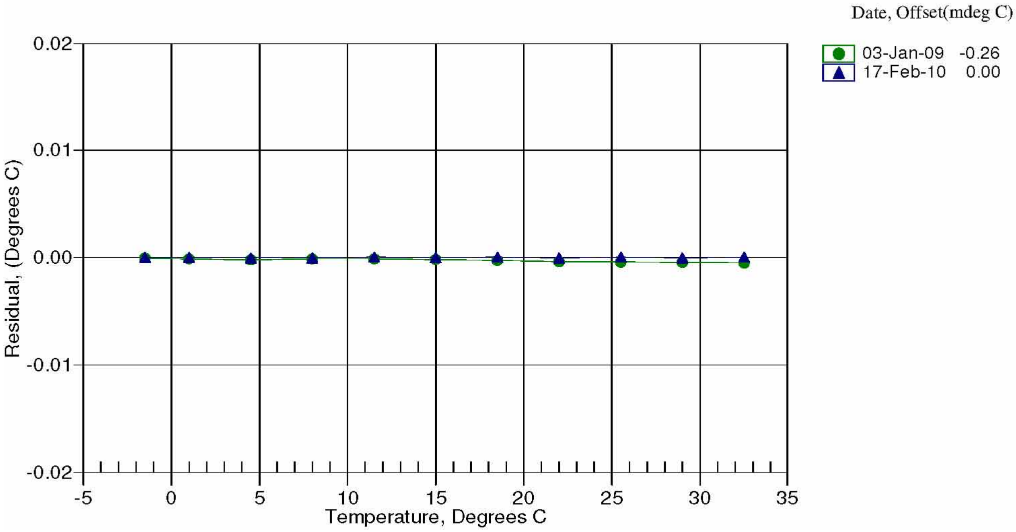
BATH TEMP (ITS-90)	INSTRUMENT FREQ (Hz)	INST TEMP (ITS-90)	RESIDUAL (ITS-90)
-1.5000	3002.273	-1.5000	0.00001
1.0000	3174.476	1.0000	-0.00001
4.5000	3427.399	4.5000	-0.00002
8.0000	3694.483	8.0000	-0.00003
11.4999	3976.102	11.4999	0.00004
15.0000	4272.632	15.0000	0.00000
18.5000	4584.418	18.5000	0.00004
22.0000	4911.791	21.9999	-0.00006
25.5000	5255.112	25.5000	0.00004
29.0000	5614.658	28.9999	-0.00006
32.5000	5990.773	32.5000	0.00003

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

Temperature 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



Temperature Sensor # 2

SEA-BIRD ELECTRONICS, INC.

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

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

SENSOR SERIAL NUMBER: 2824
CALIBRATION DATE: 18-Feb-10

SBE3 TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

ITS-90 COEFFICIENTS

g = 4.32220968e-003
h = 6.37071476e-004
i = 2.19805399e-005
j = 2.07366763e-006
f0 = 1000.0

IPTS-68 COEFFICIENTS

a = 3.68121172e-003
b = 5.98231404e-004
c = 1.55389549e-005
d = 2.07514524e-006
f0 = 2828.697

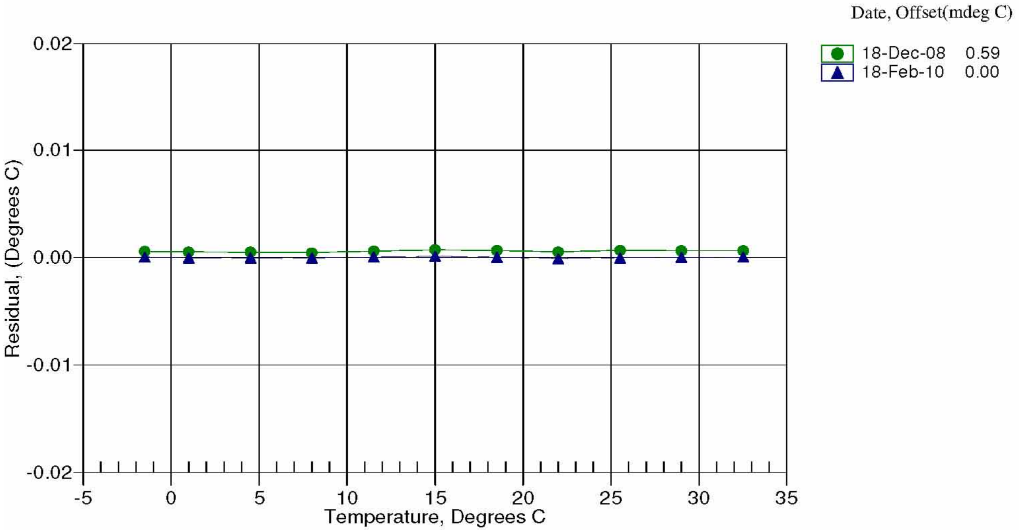
BATH TEMP (ITS-90)	INSTRUMENT FREQ (Hz)	INST TEMP (ITS-90)	RESIDUAL (ITS-90)
-1.5000	2828.697	-1.5000	0.00004
1.0000	2992.244	1.0000	-0.00003
4.5000	3232.567	4.5000	-0.00005
8.0000	3486.477	8.0000	-0.00004
11.5000	3754.347	11.5000	0.00003
15.0000	4036.533	15.0001	0.00012
18.5000	4333.366	18.5000	0.00002
22.0000	4645.197	21.9999	-0.00010
25.5000	4972.371	25.5000	-0.00003
29.0000	5315.180	29.0000	-0.00000
32.5000	5673.930	32.5000	0.00003

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

Temperature 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



Conductivity Sensor # 1

SEA-BIRD ELECTRONICS, INC.

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

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

SENSOR SERIAL NUMBER: 2545
CALIBRATION DATE: 18-Feb-10

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

GHIJ COEFFICIENTS

g = -1.06768024e+001
h = 1.64151494e+000
i = -9.54025730e-004
j = 1.89611887e-004
CPcor = -9.5700e-008 (nominal)
CTcor = 3.2500e-006 (nominal)

ABCDM COEFFICIENTS

a = 2.82397698e-005
b = 1.63950474e+000
c = -1.06736300e+001
d = -8.45121546e-005
m = 4.6
CPcor = -9.5700e-008 (nominal)

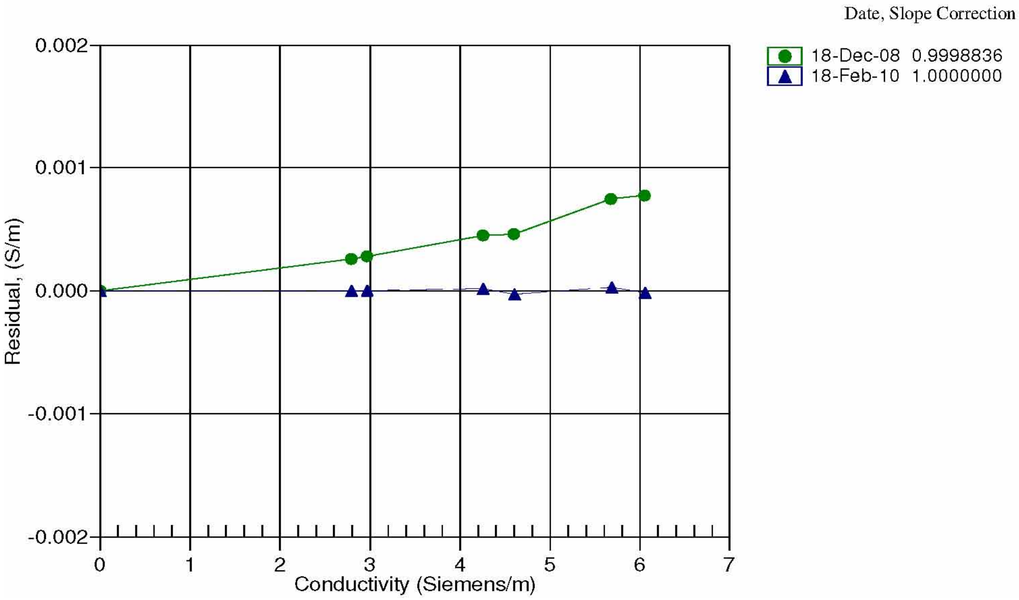
BATH TEMP (ITS-90)	BATH SAL (PSU)	BATH COND (Siemens/m)	INST FREQ (kHz)	INST COND (Siemens/m)	RESIDUAL (Siemens/m)
0.0000	0.0000	0.00000	2.55127	0.00000	0.00000
-1.0001	34.6765	2.79435	4.85073	2.79435	-0.00000
0.9999	34.6770	2.96518	4.95672	2.96518	0.00000
14.9999	34.6771	4.25633	5.69392	4.25635	0.00002
18.4999	34.6773	4.60191	5.87541	4.60188	-0.00003
28.9999	34.6753	5.68181	6.40929	5.68184	0.00003
32.4999	34.6686	6.05313	6.58272	6.05311	-0.00002

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

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

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

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



Conductivity Sensor # 2

SEA-BIRD ELECTRONICS, INC.

13431 NE 20th Street, Bellevue, Washington, 98005-2010 USA
Phone: (425) 643 - 9866 Fax (425) 643 - 9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 2575
CALIBRATION DATE: 18-Feb-10

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

GHIJ COEFFICIENTS

```
g = -1.03109387e+001
h =  1.53071304e+000
i = -9.73015792e-005
j =  9.74575626e-005
CPcor = -9.5700e-008 (nominal)
CTcor =  3.2500e-006 (nominal)
```

ABCDM COEFFICIENTS

```
a =  8.54785193e-005
b =  1.53052753e+000
c = -1.03109029e+001
d = -8.57066107e-005
m =  4.0
CPcor = -9.5700e-008 (nominal)
```

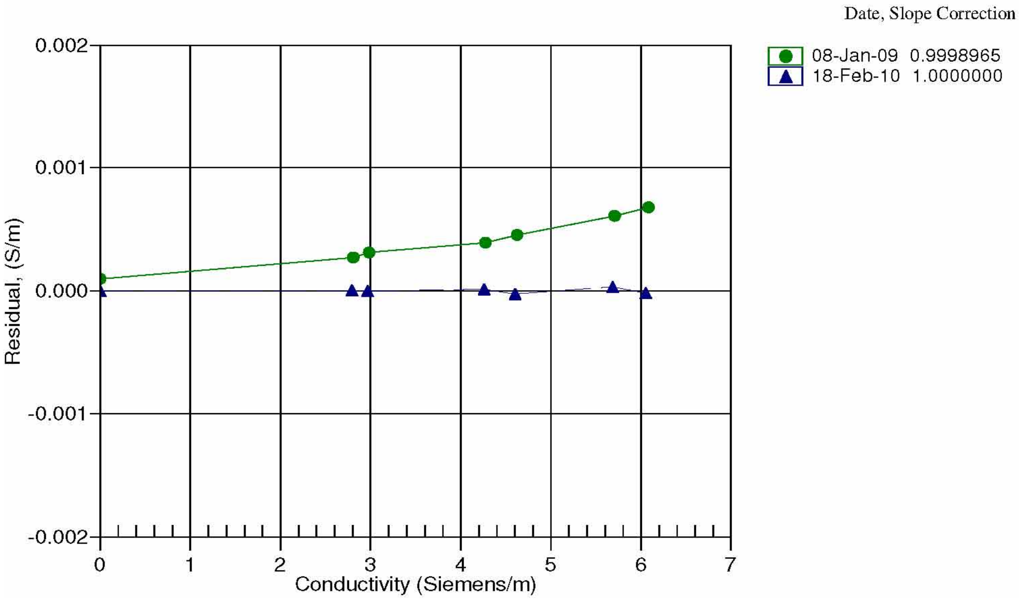
BATH TEMP (ITS-90)	BATH SAL (PSU)	BATH COND (Siemens/m)	INST FREQ (kHz)	INST COND (Siemens/m)	RESIDUAL (Siemens/m)
0.0000	0.0000	0.00000	2.59505	0.00000	0.00000
-1.0001	34.6765	2.79435	4.99595	2.79436	0.00000
0.9999	34.6770	2.96518	5.10612	2.96518	-0.00000
14.9999	34.6771	4.25633	5.87204	4.25634	0.00001
18.4999	34.6773	4.60191	6.06051	4.60188	-0.00003
28.9999	34.6753	5.68181	6.61475	5.68184	0.00003
32.4999	34.6686	6.05313	6.79476	6.05311	-0.00002

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

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

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

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



PAR Sensor

Calibration Date: 05/28/10 **Job No.:** R10533
Model Number: QSP2300
Serial Number: 70112
Operator: TPC
Standard Lamp: GS-1024(8/28/08)
Operating Voltage Range: 6 to 15 VDC (+)

Note: The QSP2300 output is a voltage that is proportional to the log of the incident irradiance.
To calculate irradiance, use this formula:
Irradiance = Calibration factor * (10^Light Signal Voltage - 10^Dark Voltage)

Dry Calibration Factor:	**2.93E+12**	**quanta/cm²·sec per volt**	**4.86E-06**	**µEinsteins/cm²·sec per volt**
Wet Calibration Factor:	**4.93E+12**	**quanta/cm²·sec per volt**	**8.18E-06**	**µEinsteins/cm²·sec per volt**

Sensor Test Data and Results[2)]

Sensor Supply Current (Dark):	3.7	mA		
Supply Voltage:	6	Volts		
Lamp Integrated PAR Irradiance:	9.27E+15	quanta/cm²·sec	0.01540	µEinsteins/cm²sec
Immersion Coefficient:	0.594			

Nominal Filter OD	Expected Transmission	Calibrated Trans.	Sensor Voltage	Expected Voltage	Voltage % Error	Measured Trans.	Transmission Error (%)	Test Irrad. (quanta/ cm²·sec)
No Filter	100%	100.00%	3.501	3.501	0%	100.00%	0.0	9.27E+15
0.3	50%	36.10%	3.061	3.059	0%	36.29%	-0.5	3.36E+15
0.5	32%	27.60%	2.949	2.942	0%	28.03%	-1.5	2.60E+15
1	10%	9.27%	2.488	2.468	1%	9.68%	-4.2	8.97E+14
2	1%	1.11%	1.583	1.546	2%	1.18%	-5.6	1.09E+14
3	0.10%	0.05%	0.398	0.229	43%	0.05%	13.8	4.39E+12
RG780	0.00%	0.00%	0.753	0.006	99%	0.15%	-100.0	1.36E+13

Dark Before:	0.006	Volts
Light - No Filter Hldr.:	3.501	Volts
Dark After - NFH:	0.006	Volts
Average Dark	0.0060	Volts

Notes:
1. Annual calibration is recommended.
2) This section is for internal use and for more advanced analysis.

24 Bottle Rossette

Pressure Sensor #1

SEA-BIRD ELECTRONICS, INC.
13431 NE 20th Street, Bellevue, Washington, 98005-2010 USA
Phone: (425) 643 - 9866 Fax (425) 643 - 9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 0639
CALIBRATION DATE: 26-Mar-10

SBE9plus PRESSURE CALIBRATION DATA
10000 psia S/N 83012

DIGIQUARTZ COEFFICIENTS:

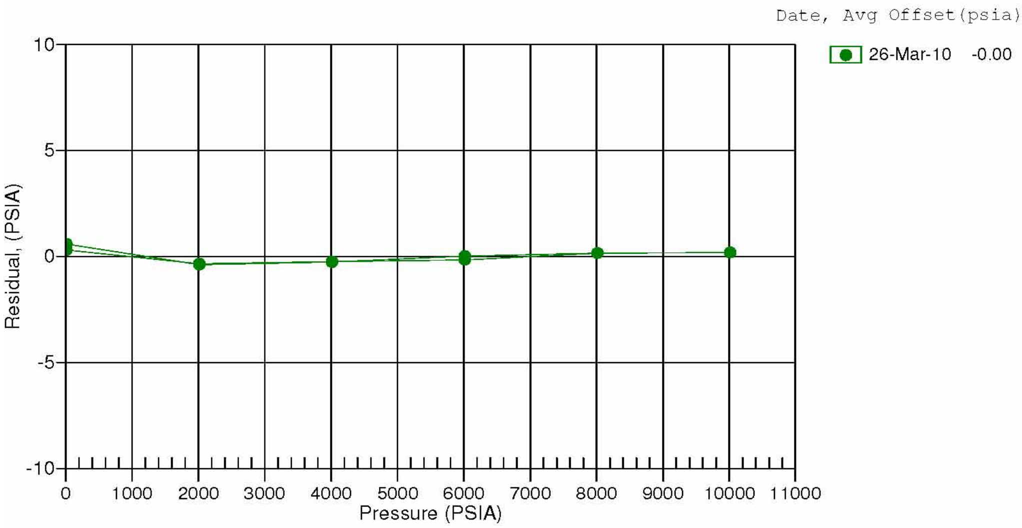
```
C1 =   -3.840384e+004
C2 =   -2.736111e-001
C3 =    1.081720e-002
D1 =    3.215400e-002
D2 =    0.000000e+000
T1 =    3.019013e+001
T2 =   -1.599643e-004
T3 =    3.601120e-006
T4 =    4.889920e-009
T5 =    0.000000e+000
```

AD590M, AD590B, SLOPE AND OFFSET:

```
AD590M =    1.27551e-002
AD590B =   -9.09133e+000
Slope =     0.99959
Offset =   -0.4735 (dbars)
```

PRESSURE (PSIA)	INST OUTPUT(Hz)	INST TEMP(C)	INST OUTPUT (PSIA)	CORRECTED INST OUTPUT (PSIA)	RESIDUAL (PSIA)
14.677	33132.18	21.7	15.951	15.263	0.586
2015.051	33982.26	21.8	2016.173	2014.663	-0.389
4014.894	34809.10	21.8	4016.964	4014.629	-0.265
6014.834	35614.22	21.9	6018.013	6014.854	0.020
8014.614	36398.86	21.9	8018.752	8014.769	0.155
10014.730	37164.55	21.9	10019.722	10014.916	0.186
8014.712	36398.90	21.9	8018.851	8014.869	0.157
6014.799	35614.13	21.9	6017.795	6014.636	-0.163
4014.805	34809.07	21.9	4016.896	4014.561	-0.243
2014.904	33982.21	21.9	2016.062	2014.551	-0.353
14.681	33132.06	22.0	15.673	14.986	0.305

Residual = corrected instrument pressure - reference pressure



Temperature Sensor # 1

SEA-BIRD ELECTRONICS, INC.

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

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

SENSOR SERIAL NUMBER: 2841
CALIBRATION DATE: 18-Feb-10

SBE3 TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

ITS-90 COEFFICIENTS

g = 4.36165846e-003
h = 6.43389137e-004
i = 2.26747396e-005
j = 2.09199561e-006
f0 = 1000.0

IPTS-68 COEFFICIENTS

a = 3.68121185e-003
b = 6.01382358e-004
c = 1.58259849e-005
d = 2.09350404e-006
f0 = 2991.079

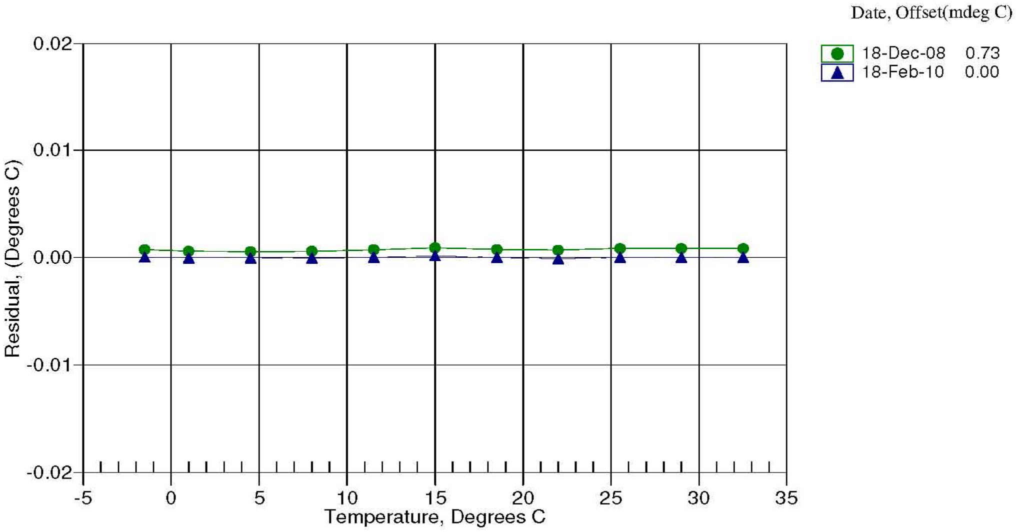
BATH TEMP (ITS-90)	INSTRUMENT FREQ (Hz)	INST TEMP (ITS-90)	RESIDUAL (ITS-90)
-1.5000	2991.079	-1.5000	0.00003
1.0000	3163.086	1.0000	-0.00003
4.5000	3415.759	4.5000	-0.00002
8.0000	3682.616	7.9999	-0.00006
11.5000	3964.049	11.5000	0.00002
15.0000	4260.425	15.0001	0.00014
18.5000	4572.075	18.5000	0.00000
22.0000	4899.371	21.9999	-0.00011
25.5000	5242.668	25.5000	0.00000
29.0000	5602.256	29.0000	0.00000
32.5000	5978.457	32.5000	0.00002

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



Temperature Sensor # 2

SEA-BIRD ELECTRONICS, INC.
13431 NE 20th Street, Bellevue, Washington, 98005-2010 USA
Phone: (425) 643 - 9866 Fax (425) 643 - 9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 2855
CALIBRATION DATE: 16-Feb-10

SBE3 TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

ITS-90 COEFFICIENTS
g = 4.35899810e-003
h = 6.44509512e-004
i = 2.29728305e-005
j = 2.14870444e-006
f0 = 1000.0

IPTS-68 COEFFICIENTS
a = 3.68121181e-003
b = 6.02244728e-004
c = 1.59763783e-005
d = 2.15023379e-006
f0 = 2973.223

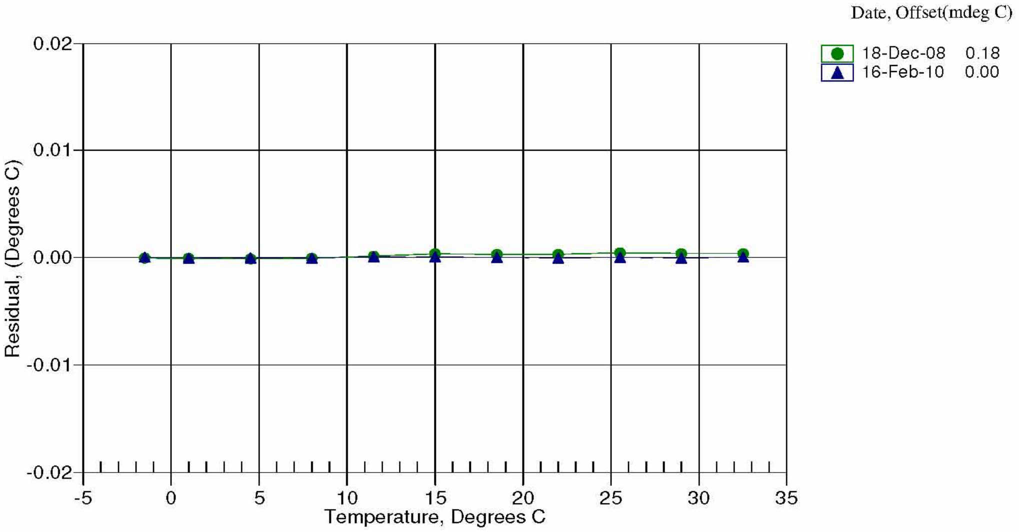
BATH TEMP (ITS-90)	INSTRUMENT FREQ (Hz)	INST TEMP (ITS-90)	RESIDUAL (ITS-90)
-1.5000	2973.223	-1.5000	0.00004
1.0000	3143.953	1.0000	-0.00002
4.5000	3394.730	4.5000	-0.00005
8.0000	3659.568	8.0000	-0.00004
11.5000	3938.847	11.5001	0.00006
15.0000	4232.919	15.0001	0.00007
18.5000	4542.137	18.5000	0.00000
22.0000	4866.851	21.9999	-0.00006
25.5000	5207.404	25.5000	0.00002
29.0000	5564.083	28.9999	-0.00007
32.5000	5937.230	32.5001	0.00005

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



Conductivity Sensor # 1

SEA-BIRD ELECTRONICS, INC.

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

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

SENSOR SERIAL NUMBER: 2568
CALIBRATION DATE: 18-Feb-10

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

GHIJ COEFFICIENTS

g = -1.03889686e+001
h = 1.48584525e+000
i = 4.73861206e-005
j = 8.41988568e-005
CPcor = -9.5700e-008 (nominal)
CTcor = 3.2500e-006 (nominal)

ABCDM COEFFICIENTS

a = 1.34873531e-004
b = 1.48573158e+000
c = -1.03885967e+001
d = -8.30450813e-005
m = 3.8
CPcor = -9.5700e-008 (nominal)

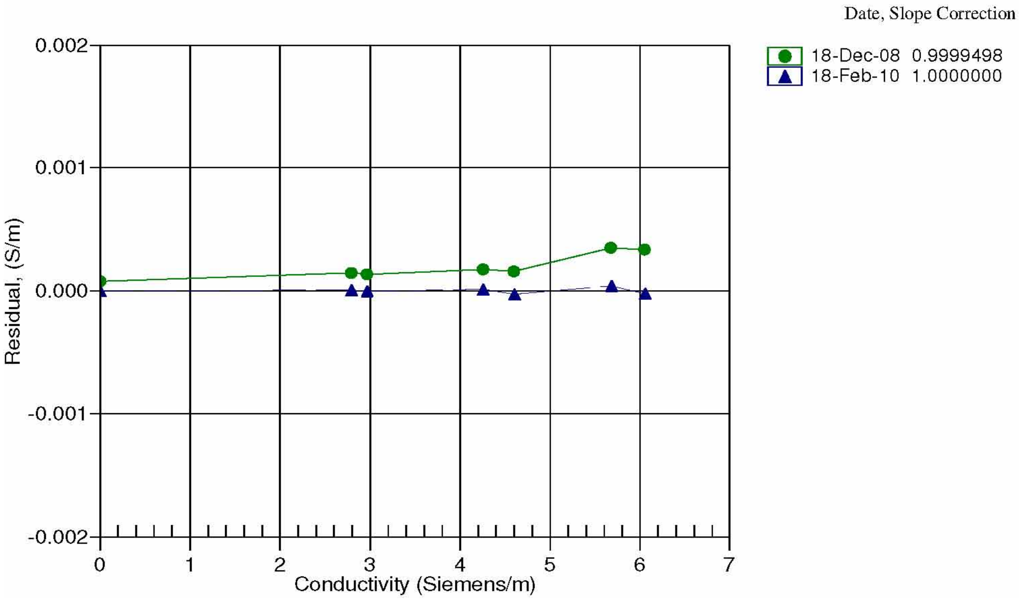
BATH TEMP (ITS-90)	BATH SAL (PSU)	BATH COND (Siemens/m)	INST FREQ (kHz)	INST COND (Siemens/m)	RESIDUAL (Siemens/m)
0.0000	0.0000	0.00000	2.64360	0.00000	0.00000
-1.0001	34.6765	2.79435	5.07510	2.79436	0.00001
0.9999	34.6770	2.96518	5.18678	2.96518	-0.00000
14.9999	34.6771	4.25633	5.96329	4.25634	0.00001
18.4999	34.6773	4.60191	6.15439	4.60188	-0.00003
28.9999	34.6753	5.68181	6.71643	5.68185	0.00004
32.4999	34.6686	6.05313	6.89898	6.05311	-0.00002

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

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

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

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



Conductivity Sensor # 2

SEA-BIRD ELECTRONICS, INC.

13431 NE 20th Street, Bellevue, Washington, 98005-2010 USA
Phone: (425) 643 - 9866 Fax (425) 643 - 9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 2561
CALIBRATION DATE: 18-Mar-10

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

GHIJ COEFFICIENTS

```
g = -1.07643150e+001
h =  1.66861842e+000
i = -1.12059488e-003
j =  1.87425888e-004
CPcor = -9.5700e-008 (nominal)
CTcor =  3.2500e-006 (nominal)
```

ABCDM COEFFICIENTS

```
a =  1.26353370e-005
b =  1.66620737e+000
c = -1.07605733e+001
d = -8.58445379e-005
m =  4.9
CPcor = -9.5700e-008 (nominal)
```

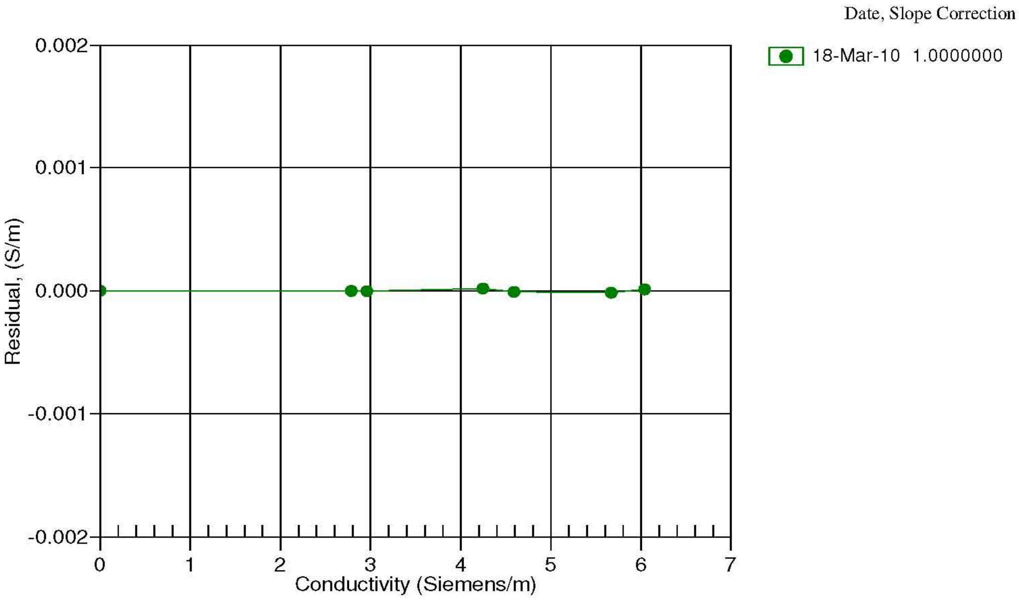
BATH TEMP (ITS-90)	BATH SAL (PSU)	BATH COND (Siemens/m)	INST FREQ (kHz)	INST COND (Siemens/m)	RESIDUAL (Siemens/m)
0.0000	0.0000	0.00000	2.54114	0.00000	0.00000
-1.0000	34.5816	2.78743	4.81358	2.78742	-0.00000
1.0000	34.5822	2.95785	4.91850	2.95785	-0.00000
15.0000	34.5822	4.24592	5.64843	4.24594	0.00002
18.5000	34.5818	4.59061	5.82816	4.59060	-0.00001
28.9999	34.5799	5.66793	6.35697	5.66791	-0.00002
32.4999	34.5711	6.03804	6.52867	6.03805	0.00001

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

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

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

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



Oxygen Sensor

SEA-BIRD ELECTRONICS, INC.

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

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

SENSOR SERIAL NUMBER: 0456
CALIBRATION DATE: 05-Mar-10p

SBE 43 OXYGEN CALIBRATION DATA

COEFFICIENTS

Soc = 0.5569
Voffset = -0.5193
Tau20 = 1.26

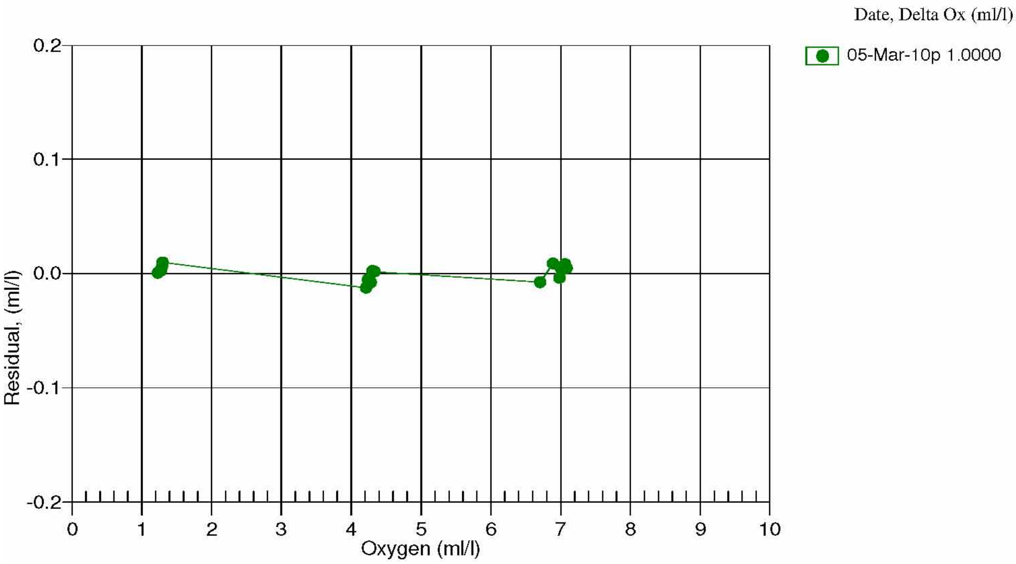
A = -2.5635e-003
B = 9.5529e-005
C = -1.8047e-006
E nominal = 0.036

NOMINAL DYNAMIC COEFFICIENTS

D1 = 1.92634e-4 H1 = -3.30000e-2
D2 = -4.64803e-2 H2 = 5.00000e+3
H3 = 1.45000e+3

BATH OX (ml/l)	BATH TEMP ITS-90	BATH SAL PSU	INSTRUMENT OUTPUT(VOLTS)	INSTRUMENT OXYGEN(ml/l)	RESIDUAL (ml/l)
1.23	2.00	0.01	0.749	1.23	0.00
1.24	6.00	0.01	0.778	1.24	0.00
1.26	12.00	0.01	0.826	1.26	0.00
1.27	20.00	0.02	0.890	1.28	0.00
1.29	26.00	0.02	0.944	1.30	0.01
1.30	30.00	0.02	0.983	1.31	0.01
4.21	2.00	0.01	1.302	4.20	-0.01
4.24	6.00	0.01	1.403	4.23	-0.01
4.26	12.00	0.01	1.554	4.26	-0.01
4.28	20.00	0.02	1.759	4.27	-0.01
4.31	26.00	0.02	1.929	4.31	0.00
4.34	30.00	0.02	2.053	4.34	0.00
6.71	30.00	0.02	2.888	6.70	-0.01
6.89	26.00	0.02	2.778	6.90	0.01
6.98	20.00	0.02	2.544	6.98	-0.00
7.03	12.00	0.01	2.228	7.03	0.00
7.06	6.00	0.01	1.995	7.07	0.01
7.09	2.00	0.01	1.842	7.09	0.00

Oxygen (ml/l) = Soc * (V + Voffset) * (1.0 + A * T + B * T^2 + C * T^3) * OxSol(T,S) * exp(E * P / K)
V = voltage output from SBE43, T = temperature [deg C], S = salinity [PSU] K = temperature [deg K]
OxSol(T,S) = oxygen saturation [ml/l], P = pressure [dbar], Residual = instrument oxygen - bath oxygen



Fluorometer

CERTIFICATE OF CALIBRATION

All test equipment and standards used are of known accuracy and are traceable to national standards. Details of test equipment and standards relevant to this certificate are available upon request.

Chelsea
Technologies
Group

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sales@chelsea.co.uk
www.chelsea.co.uk

Date of issue	**12 Feb 2010**
Description	Mk III Aquatracka (Chlorophyll-a)
Serial Number	088234
Part No	088-3598C

REPORT

The fluorimeter was exposed to various concentrations of Chlorophyll-a dissolved in acetone in addition to pure water and pure acetone. The following formula was derived from the readings to relate instrument output to chlorophyll-a concentration.

$$\text{Conc.} = (0.00976 \times 10^{\text{Output}}) - 0.0185$$

Where:-

conc. = fluorophor concentration in µg/l
Output = Aquatracka output in volts

The above formula can be used in the range 0 - 100 microgrammes per litre to an uncertainty of 0.03 microgrammes per litre plus 7% of value.

Notes

The above formula has been derived using Chlorophyll-a dissolved in acetone. No guarantee is given as to the performance of the instrument to biologically active chlorophyll in sea-water.

The zero offset has been determined in the laboratory using purified water from a reverse osmosis/ion exchange column. It is possible that purer water may be found in clean deep ocean conditions. Under these conditions, the offset shown in the above formula should be replaced by the antilogarithm of the Aquatracka output in the purest water found, multiplied by the scale factor.

Serial number 88234 Page 1 of 2

Group Companies

Chelsea Technologies Ltd
Chelsea Instruments Ltd
Chelsea Environmental Ltd
Marine Acoustics Ltd

Fluorimeter calibration readings

Ambient temperature 20°C

Output for detector mechanically blanked 0.487560 Volts

Output for pure water 0.2777 Volts

chlorophyll concentration in acetone (µg/l)	Output (volts)
Acetone (pure)	0.5084
0.1	1.1892
0.3	1.5425
1.0	2.1289
2.99	2.4760
9.9	2.9988
29.1	3.4732
90.9	3.9549

The uncertainty of the chlorophyll concentration is estimated not to exceed 3%. The uncertainty of output voltage measurement is estimated not to exceed 2mV.

Equipment used during calibration :-
Thurlby Dvm Cil 024
Weir Psu Cil 098

Gravimeters

BGM 221

This is the most current Calibration Sheet available.

BASE CALIBRATION READINGS

BGM S/N: 221 /AARV SURVOPS:____ ACC NO:____

SHIP: HEALY SURVOPS DATES:____ TO:____

PORTS: SEATTLE, WA TO:____

PERSONNEL: HERR

DEPARTURE BASE CALIBRATION READINGS

DATE: 29 FEB 08 J.D. 060 TIME GMT: 1700 TO: 1800 MEAN: 1730

STA.# :____

STA. NAME: PIER 36	STA GRAV @ PIER LEVEL	980728.35	MGALS
	PIER STA HGT 7.4' X .094 +	.70	MGALS
	BASE g @ WATER LEVEL	980729.05	MGALS
S.F.: 5.017387	BGM OBS GRAV	980729.34	MGALS
CORR. BIAS : 855284.64	OBS g – BASE g	+ 0.29	MGALS

DRIFT CORR. ENTERED: N/A

ARRIVAL BASE CALIBRATION READINGS

DATE:____ J.D.:____ TIME GMT:____ TO:____ MEAN:____

STA.#:____

STA. NAME:____	STA GRAV @ PIER LEVEL	____	MGALS
	PIER STA HGT____ X .094 +	____	MGALS
	BASE g @ WATER LEVEL	____	MGALS
S.F.:____	BGM OBS GRAV	____	MGALS
CORR. BIAS:____	OBS g – BASE g	____	MGALS

LAND METER NO. ____

DEPARTURE	J. D.:____	TIME GMT:____	VALUE:____	C.D. =	____	MGALS
ARRIVAL	J. D.:____	TIME GMT:____	VALUE:____	C.D. =	____	MGALS
				DIFFERENCE:	____	MGALS
				STA.GRAV @ PIER LEVEL DIFFERENCE:	____	MGALS
				MISTIE:	____	MGALS

BCR BY:____ CHECKED BY:____

BGM 222

This is the most current Calibration Sheet available.

BASE CALIBRATION READINGS

BGM S/N: 222/HEALY SURVOPS: ______ ACC NO: ______

SHIP: HEALY SURVOPS DATES: ______ TO: ______

PORTS: SEATTLE, WA TO: ______

PERSONNEL: HERR

DEPARTURE BASE CALIBRATION READINGS

DATE: 29 FEB 08 J.D. 060 TIME GMT: 1700 TO: 1800 MEAN: 1730

STA.# : ______

STA. NAME: PIER 36	STA GRAV @ PIER LEVEL	980728.35	MGALS
	PIER STA HGT 7.4' X .094 +	.70	MGALS
	BASE g @ WATER LEVEL	980729.05	MGALS
S.F.: 4.949006	BGM OBS GRAV	980729.26	MGALS
CORR. BIAS: 856740.23	OBS g – BASE g	+0.21	MGALS

DRIFT CORR. ENTERED: N/A

ARRIVAL BASE CALIBRATION READINGS

DATE: ______ J.D.: ______ TIME GMT: ______ TO: ______ MEAN: ______ .

STA.#: ______

STA. NAME: ______	STA GRAV @ PIER LEVEL	______	MGALS
	PIER STA HGT ______ X .094 +	______	MGALS
	BASE g @ WATER LEVEL	______	MGALS
S.F.: ______	BGM OBS GRAV	______	MGALS
CORR. BIAS: ______	OBS g – BASE g	______	MGALS

LAND METER NO. ______

DEPARTURE J. D.: ______ TIME GMT: ______ VALUE: ______ C.D. = ______ MGALS

ARRIVAL J. D.: ______ TIME GMT: ______ VALUE: ______ C.D. = ______ MGALS

DIFFERENCE: ______ MGALS

STA.GRAV @ PIER LEVEL DIFFERENCE: ______ MGALS

MISTIE: ______ MGALS

BCR BY: ______ CHECKED BY: ______

Correlate versus Envelope data for the Sub Bottom "SEGY" data

Chirp Sub-Bottom Profiler Processing—A Review

Chirp Signals May be Recorded as Correlates, Analytic or Envelope

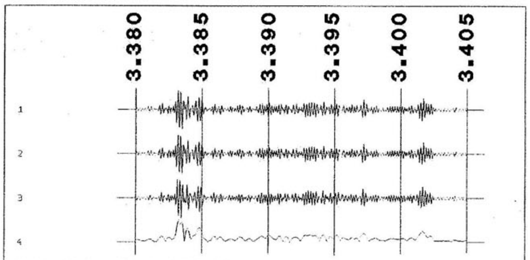
By Paul Henkart
Geophysical Analyst
Scripps Institution of Oceanography
La Jolla, California

Hull-mounted and towed sub-bottom profilers have become common within the U.S. academic community. While these systems may be marketed as "echosounder" or "bathymetric," they are far more powerful and complex than the depth finders of years ago. Echosounders typically used a constant waveform signal of 3.5 or 12 kilohertz, measuring the two-way travel time to the seafloor and sometimes penetrating the sub-bottom. The replacement sub-bottom profilers emit a chirp signal that is usually several kilohertz wide and often penetrates the bottom 100 meters or more.

In the early days of chirp sub-bottom profiler development, the profilers required specialists or experts in order to operate them. These days, the chirp profiler is considered just another underway data acquisition device, and the shipboard technician may not have had much training in its use.

The chirp profiler operator must choose recording and display parameters, such as gain and chirp frequency. Hull-mounted profilers are more than likely found on oceanographic ships with a multibeam echosounder mapping system operating at 12 kilohertz and a current profiler operating at 50 kilohertz. Sub-bottom profilers get more depth penetration with low frequency, thus, a chirp center frequency near the old 3.5 kilohertz is generally used.

Many of the chirp recording and processing parameters are similar to the old echosounder parameters. Some chirp systems even use the same transducers, so the transducer transmit and receive gain functions are the same. The display on the old echosounders consisted of burning a spot on a piece of paper so that an increase in seismic amplitude caused a more intense burn spot. Today's profilers create grayscale plots of the signal envelope on computer monitors and thermal raster plotters.



1. Correlate from a Knudsen 320B profiler
2. Reals from the analytic or complex signal (the correlate itself)
3. Imaginaries from the analytic or complex signal (the Hilbert transform of the correlate)
4. Envelope formed from the complex modulus of the analytic signal

A comparison of the time domain of the correlate, analytic and envelope signals.

Variable Velocity

The old echosounders were used mostly to measure seafloor depth, and periodically recorded the depth as a number in addition to the paper record. These systems used a single velocity value (750 meters per second) to convert two-way travel time to depth. Expendable bathythermographs (XBTs) were, and still are, deployed to measure the velocity of sound in water, but the old depth systems applied the varying velocity after the fact—in the shoreside laboratory months later. Today's bathymetric multibeam mapping systems allow the full XBT velocity function, and allow this to vary spatially in real time. There could/should be a whole article written just on the different types of velocity functions used to convert time to depth. A marine technician must know which system uses which velocity function for which purpose. A technician also has to educate everybody onboard as to why there is a difference among the depth readings from the different systems.

Types of Signals

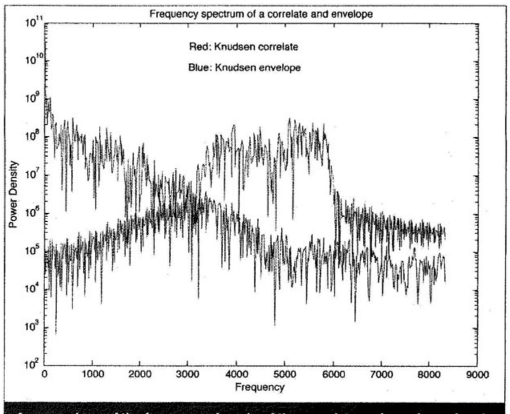
The modern sub-bottom profiler chirp signal is typically 20 to 50 milliseconds in length and sweeps three to four-kilohertz frequencies in that time. One hull-mounted profiler manufacturer uses a four-kilohertz-wide signal with a center frequency of 3.5 kilohertz (sweeping from 1.5 to 5.5 kilohertz) and another sweeps from three to six kilohertz (a three-kilohertz bandwidth with a center frequency of 4.5 kilohertz). Increasing the length of the outgoing signal increases the power of the outgoing signal.

Generally, the chirp signal takes the following path or steps: it is generated by the transducer, it reflects back off of some object, it is received by the transducer, it is digitized and processed, and it is written to some storage medium and displayed.

The gain, or signal power, may be adjusted at the transducer during send and receive stages, as well as during the processing stage, usually just prior to display. The transmit/receive gain adjustments are independent of each other, but are a constant shift in power. All signal amplitudes are adjusted by the same amount. The gain adjustment during processing may vary with two-way travel time, and usually start from a selected water bottom time (i.e., they are "hung" from the seafloor). Time varying gain (TVG) is inadequate when the water bottom can not be picked, so automatic gain control may be an option.

In principle, the chirp signal is the same as the seismic industry's Vibroseis sweep signal. Most introductory courses in geophysics, *Seismic Data Analysis* by Oz Yilmaz and *Encyclopedic Dictionary* by Robert E. Sheriff cover the convolutional theory of acoustic signals traveling through the Earth and Vibroseis processing.

The first sweep signal processing step is to deconvolve, correlate or match filter the transmitted signal with the received signal. This way, the long outgoing sweep signal is compressed and the resulting signal is similar to the conventional seismic signal. The correlation step is best left to the manufacturer's recording device, since it requires knowledge of the exact outgoing signal.



A comparison of the frequency domain of the correlate and envelope signals.

The marine sub-bottom profiler is different from the land Vibroseis system in that Vibroseis sweeps are much lower in frequency (often less than 100 hertz), while the marine chirp systems are more than several kilohertz. The marine chirp systems use additional signal processing techniques to lower the frequency content so that the signals can be displayed the particular manner the seismic user is accustomed to seeing them.

The next processing step is to divide the correlated signal (the correlate) into two parts. The first part is untouched and the second one is phase shifted by 90°. The phase-shifted signal is called the Hilbert transform, or quadrature.

The untouched signal and the Hilbert transform are then merged into a new single signal to form the analytic, or complex signal. The analytic signal resembles a complex number in that each sample has two computer words, similar to a complex number. The real part of each sample is the original signal, and the imaginary part of each sample is the corresponding Hilbert transform. The analytic signal has twice the number of computer words, or bytes, as the correlate because each sample has two words: the real and the imaginary.

The complex modulus (square root of the sum of squares of the real and imaginary) of each sample is formed from the analytic signal and becomes the envelope, or instantaneous amplitude. The envelope contains only positive numbers, and no longer has any phase information, but it is much lower in frequency and can be displayed as the geologist/geophysicist is accustomed to. The envelope is the same length and has the same sample interval as the correlate.

What to Record

Sub-bottom profilers offer digital output in addition to a real-time display of the envelope data. The digital output is often formatted similar to the Society of Exploration Geophysicist (SEG)-Y standard. But, the output may be from any of the intermediary processing steps. The SEG-Y file may contain one of the following signals: the raw

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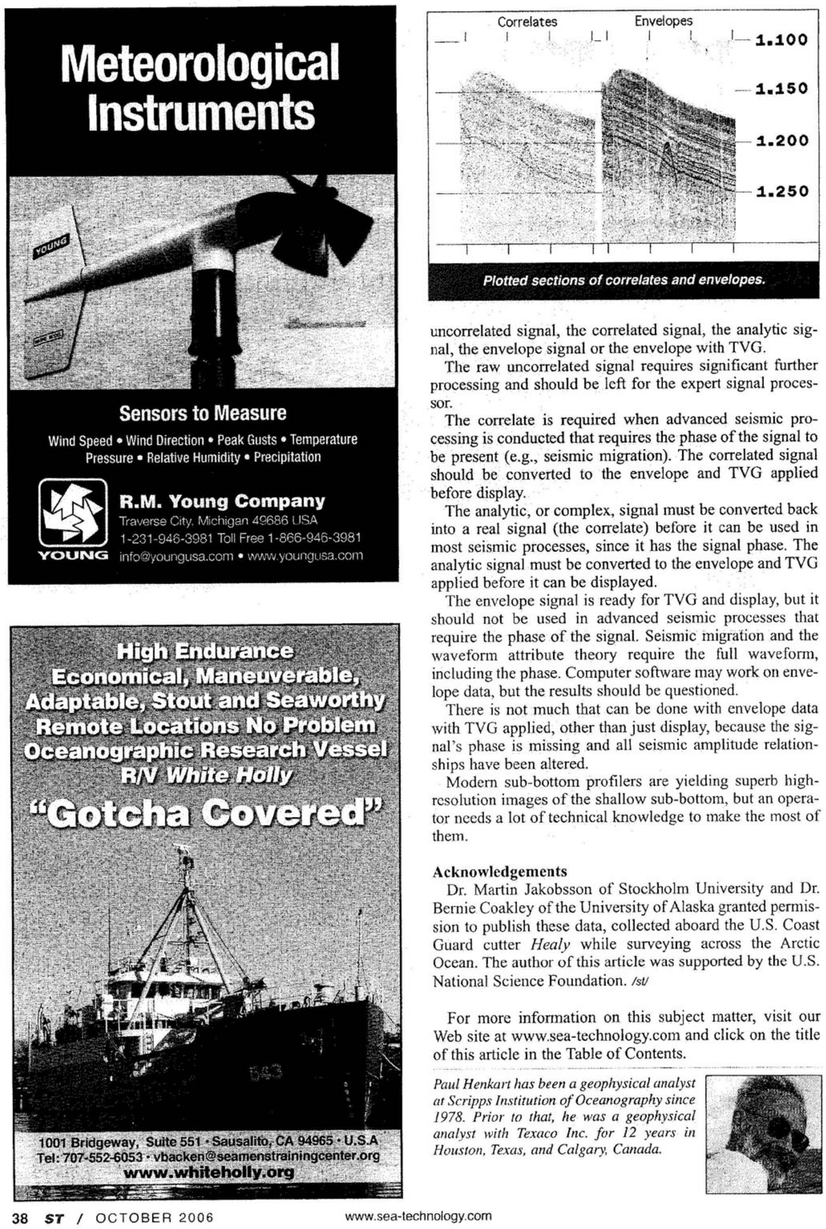


Plotted sections of correlates and envelopes.

uncorrelated signal, the correlated signal, the analytic signal, the envelope signal or the envelope with TVG.

The raw uncorrelated signal requires significant further processing and should be left for the expert signal processor.

The correlate is required when advanced seismic processing is conducted that requires the phase of the signal to be present (e.g., seismic migration). The correlated signal should be converted to the envelope and TVG applied before display.

The analytic, or complex, signal must be converted back into a real signal (the correlate) before it can be used in most seismic processes, since it has the signal phase. The analytic signal must be converted to the envelope and TVG applied before it can be displayed.

The envelope signal is ready for TVG and display, but it should not be used in advanced seismic processes that require the phase of the signal. Seismic migration and the waveform attribute theory require the full waveform, including the phase. Computer software may work on envelope data, but the results should be questioned.

There is not much that can be done with envelope data with TVG applied, other than just display, because the signal's phase is missing and all seismic amplitude relationships have been altered.

Modern sub-bottom profilers are yielding superb high-resolution images of the shallow sub-bottom, but an operator needs a lot of technical knowledge to make the most of them.

Acknowledgements

Dr. Martin Jakobsson of Stockholm University and Dr. Bernie Coakley of the University of Alaska granted permission to publish these data, collected aboard the U.S. Coast Guard cutter *Healy* while surveying across the Arctic Ocean. The author of this article was supported by the U.S. National Science Foundation. /st/

For more information on this subject matter, visit our Web site at www.sea-technology.com and click on the title of this article in the Table of Contents.

Paul Henkart has been a geophysical analyst at Scripps Institution of Oceanography since 1978. Prior to that, he was a geophysical analyst with Texaco Inc. for 12 years in Houston, Texas, and Calgary, Canada.

Table of Survey measurements

This Table is **NOT** to be used for exact measurements. It is included here for getting a general understanding of instrument locations on the ship. It has not been updated since 2007, thus some instruments will be out of date or missing.

Table A.11. Table of Survey measurements

Consolidated Survey Data						
	Elements of:					
		Avondale Survey				
		Westlake Survey				

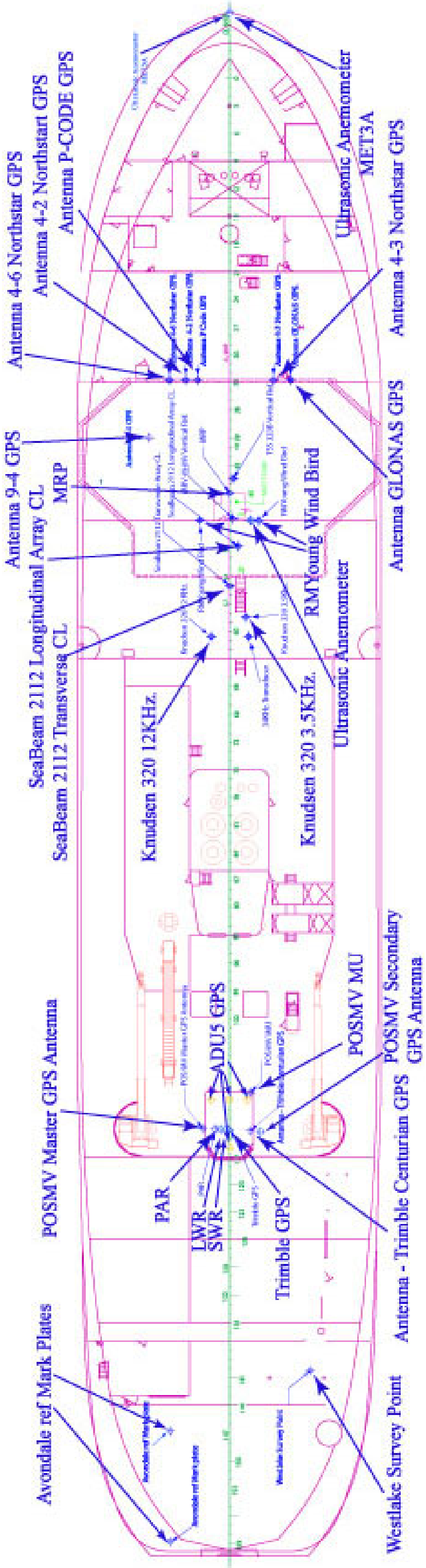
Consolidated Survey Data						
		Lamont Survey				
	Meters relative to MRP unless otherwise stated					
	X = fore & aft with + foreward					
	Y = port & starboard with + to starboard					
	Z= vertical with + upwards					
				X	Y	Z
Item	Survey	Description		North	East	Elevation
1	Avondale	MRP	See discussion Westlake Final Report	34.30	0.00	9.15
2	Westlake	MRP	by Definition	0.00	0.00	0.00
3	Westlake	EM122				
		Transverse Array	Centerline	-7.679	0.030	9.242
		Longitudinal Array	Centerline	-4.386	0.711	9.238
4	Westlake	Transducers				
		Starboard - Forward to Aft				
		Transducer -	Bathy 2000 3.5 kHz	-10.252	1.362	9.243
		Transducer -	Bathy 1500 34 kHz *	-11.866	1.559	9.245
		Transducer -	Doppler Speed Log	-12.168	0.414	9.245
		Transducer -	Spare Transducer Well	-13.081	1.449	9.237
5	Westlake	Port - Forward to Aft				
		Transducer -	VM 150	-9.726	-1.395	9.230
		Transducer -	Ocean Surveyor 75 kHz	-10.819	-1.290	9.230
		Transducer -	Bathy 2000 12 kHz	-11.859	-1.492	9.234
		Transducer -	Spare Transducer Well	-13.078	-1.394	9.235

Consolidated Survey Data						
6	Westlake	Gyros				
		Starboard Gyro	Centerline	4.741	0.207	-19.604
		Port Gyro	Centerline	4.746	-0.207	-19.609
7	Westlake	Antennas				
		REF DWG TBD	Antenna 9-4 * - GPS Antenna (4.1.5)	4.587	-6.622	-24.000
			Antenna 4-6 * - Northstar GPS (4.1.1)	9.374	-4.970	-23.406
			Antenna 4-2 * - Northstar (4.1.2)	9.362	-3.617	-23.451
			P CODE GPS Antenna *	9.368	-2.645	-23.609
			Antenna 4-3 * - Northstar (4.1.4)	9.355	3.638	-23.363
			GLONAS GPS Antenna*	9.379	5.066	-23.515
			Antenna base (4A)	-53.872	-0.011	-22.025
			Antenna base (4B)	-49.758	0.038	-22.010
			Antenna base (4C)	-49.785	1.629	-22.020
			Antenna base (4D)	-49.771	-1.546	-22.008
			Trimble Centurion**	-52.726	-1.717	-21.113
			Time Server **	-52.671	1.838	-21.115
8	Westlake	Vertical Ref				
			MRV-M-MV -			
			Measured at Top of mounting bracket			

Consolidated Survey Data						
			Center (mid-point) - calculated	-2.100	0.291	-0.775
			TSS 333B - Marine Motion Sensor -			
			scribe atop mounting plate			
			Center of TSS 333B	1.210	0.329	-0.013
9	LDEO	POS/MV				
		From	TO	X	Y	Z
		IMU	Port Antenna (Master)	-2.9719	-3.9140	-5.5310
		MRP	IMU	-49.5710	1.7110	-16.7990
		MRP	Transmit array	-4.3860	0.7110	9.2380
		MRP	Port Antenna (Master)	-52.5429	-2.2030	-22.3300
10	Westlake Raw	Fan Tail				
			Aft/Port	-86.737	-4.906	-3.617
			Forward/ Port	-77.600	-4.881	-3.589
			Forward/ Starboard	-72.590	6.676	-3.653

Layout plot of instrument locations

This layout is **NOT** to be used for exact measurements. It is included here for getting a general understanding of instrument locations on the ship. It has not been updated since 2007.


Antenna 4-6 Northstar GPS
Antenna 4-2 Northstart GPS
Antenna P-CODE GPS
Ultrasonic Anemometer
MET3A
Antenna 4-3 Northstar GPS
Antenna GLONAS GPS
Antenna 9-4 GPS
MRP
SeaBeam 2112 Longitudinal Array CL
SeaBeam 2112 Transverse CL
RMYoung Wind Bird
Ultrasonic Anemometer
Knudsen 320 12KHz.
Knudsen 320 3.5KHz.
POSMV MU
POSMV Secondary
GPS Antenna
ADU5 GPS
POSMV Master GPS Antenna
PAR
LWR
SWR
Trimble GPS
Antenna - Trimble Centurian GPS
Avondale ref Mark Plates
Westlake Survey Point

Revision History

Table A.12. Revision History of the Healy Data Description Summary Document

Date	Version	editor	Comment
-	-	Tom	The original version was part of the mondo MS-Word file
August 1-6, 2009	2.01	Dale	Converted to XML and DocBook 5.0 for HLY0904 (Pickart)
June 2010	-	Tom	Added the remaining sections of the report. Converted from Microsoft WORD to xml
August, 24 2010	-	Tom	Create new Base XML files to make the Data Report from. These are now generic File names and not spectific to a cruise. There IS some places that have specific cruise information in them. The user sould find them and adjust the infomation there to best fit the current cruise.
September 6, 2010	-	Tom	Final copy of the Report for HLY1002

Although the science component of many cruises on the Healy, including this one, are funded from various sources, science technical support is largely funded by the Arctic Section of the US National Science Foundation Office of Polar Programs through grants to the Lamont-Doherty Earth Observatory of Columbia University, the University Corporation for Atmospheric Research, the Woods Hole Oceanographic Institution, Scripps Institution of Oceanography, and through congressionally mandated budget authority for the US Coast Guard polar icebreakers.

The opinions contained in this document are those of the authors and do not represent the official positions of any organization.

This document was authored using SynchroSoft Oxygen Version 11.2 and a DocBook V5 DTD.