Data Synopsis for HLY0806

September 05 – October 01, 2008

Barrow to Barrow

Chief Scientist- Jonathan Childs

Healy Captain- Captain Frederick Sommer

Version of 2008-10-01

Prepared by: Tom Bolmer, David Forcucci, David Hassilev, Steve Roberts & Dale Chayes

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Project Summary

This cruise was a two-ship program with the Canadian Coast Guard icebreaker Louis S. St-Laurent (LSSL) and the US Coast Guard Healy. The Healy sailed from Barrow, AK and the LSSL sailed from Tuktoyuktuk, CA. The ship's met on _**month-day-year at xxxx latitude, yyyy longitude** and worked in close proximity until they separated on September 27, 2008 in the vicinity of **xxx latitude, yyy longitude**. Two modes of operation were employed during this cruise. The primary mode was multichannel seismic survey. During this mode the Healy led, breaking a channel for the LSSL to follow while towing their seismic source and streamer. The secondary mode was focused on collecting multibeam bathymetry. During multibeam-mode, the LSSL lead, breaking a channel for the Healy to follow.

2008 USGS/NRCAN

Healy – Louis Joint Science Plan (prepared before the cruise)

The primary purpose of the two-ship experiment is to collect seismic and bathymetric data in support of delineating the extended continental shelf in the western Arctic Ocean for both Canada and the United States. The extended continental shelf is that region beyond 200 nautical miles where a nation can show it satisfies the conditions of Article 76 of the United Nations Convention on the Law of the Sea. The data most relevant to fulfilling the conditions of Article 76 are bathymetric and seismic reflection data. The logistical difficulties of collecting seismic data in ice-covered regions make it much more likely that the data will be collected successfully if two icebreakers participate, one in the lead to break a path for the second following with the towed seismic acquisition system. *USCGC Healy* is equipped to collect multibeam bathymetric, high-resolution subbottom, and gravity data during the expedition and the *CCGS Louis S. St. Laurent (Louis)* is equipped to collect multichannel seismic reflection and refraction data as well as gravity data. With two ships, the priority areas will be those locations where ice cover requires a two-ship operation.

Because acquiring seismic data is the reason for having a two-ship experiment, alterations to the original science plan during the experiment need to ensure successful acquisition of seismic data with coincident bathymetric data to foot of slope, and second on obtaining additional multibeam bathymetric data. If the ice is too thick for ship profiling along the seismic profile in the vicinity of the foot of the slope, the fall-back strategy is to take spot soundings using the helicopter and use those spot sounding to define foot of slope. Ice conditions and ship location with respect to the continental margin will determine when the helicopter soundings will be employed in this manner.

Along the Canadian continental margin north of Banks Island, where the planned ship tracks are parallel to the margin, a secondary priority is to collect bathymetric data to identify the foot of the slope between the seismic profiles. To fulfill this secondary objective, it may be optimal to have *Louis* as the lead vessel to break ice for *Healy*. If ice conditions are heavy, a decision at sea will need to be made to determine how much effort to expend obtaining bathymetry along the continental margin between seismic profiles. If this secondary operation delays the seismic survey significantly, it will be abandoned and a faster route taken to the start of the next seismic line. The foot of slope information between seismic profiles is useful but not essential.

A Summary of the Joint Operations on The Louis S. St-Laurent

By: Ruth Jackson (Canadian Geological Survey) and Deborah Hutchinson (US Geological Survey)

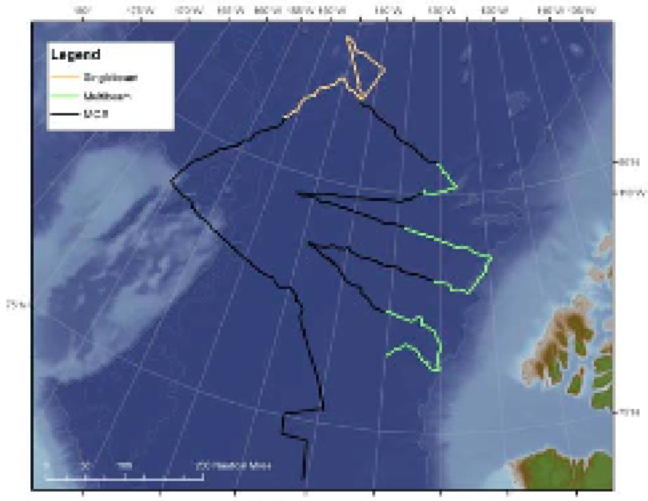
UNCLOS 2008 Arctic Ocean: Canada - U.S. Joint Expedition

The purpose of the *Louis S.St-Laurent* 2008 UNCLOS expedition is to collect data that will help define the limits of the extended continental shelf for both Canada and the United States in the Arctic Ocean. The Convention on the Law of the Sea (UNCLOS) allows every coastal state a continental shelf out to 200 nm. UNCLOS also allows coastal states, under certain circumstances, to exert sovereign rights over portions of the continental margin beyond 200 nm. The portion of the continental margin beyond 200 nm is called the extended continental shelf. Both Canada and the United States have a national interest in knowing (and declaring to others) the locations of the outer limits of their respective extended continental shelf.

Photo: Kelly Hansen

Two kinds of data are necessary for defining the outer limits of the extended continental shelf: sediment thickness and morphology. Sediment thickness information is gathered using seismic reflection techniques that canimage many kilometers beneath the sea floor. Morphology data are gathered using echo sounders which typically only image the surface of the sea floor. The collaboration between Canada and the United States grew from recognizing that Canada has developed a seismic reflection system for use in the Arctic Ocean (using *Louis S. St-Laurent*) whereas the United States operates a sophisticated multibeam echo sounder aboard its Arctic Research vessel, *Healy*.

Collaboration makes sense in the remote and harsh conditions of operating in the Arctic. Not only do the U.S. and Canada have a long history of cooperation, but the collaboration saves money for each country, provides a more complete dataset for UNCLOS purposes, and facilitates collecting these kinds of data in conditions of thick ice where it is impractical for one ship to operate.



UNCLOS 2008 Data Types

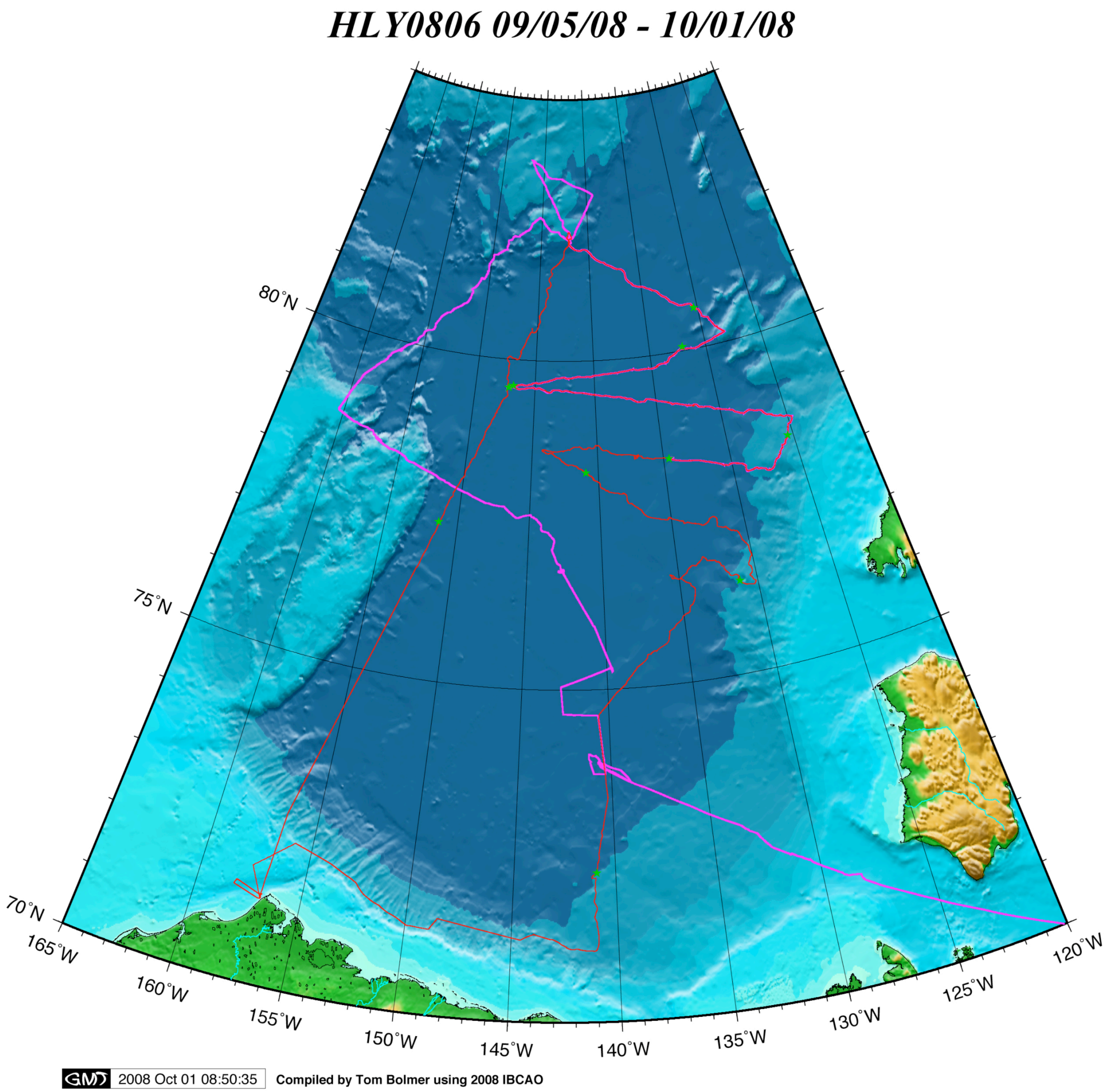
During the 2008 cruise, approximately 2800 km of multichannel seismic data were collected. Of those, ~1500 km were with *Healy* breaking ice for *Louis*. An additional ~950 km of multibeam data were collected with *Louis* breaking ice for *Healy*. Louis reached 83oN, 146o W during profiling.

In addition, these data are in regions never before explored by surface ship. Not only are the results relevant to Law of the Sea, they are also scientifically exciting forrevealing the geologic and tectonic history of the Canada Basin of the Arctic Ocean.

29 September, 2008,

Aboard *Louis S. St-Laurent*

Cruise Track



Personnel

HLY0806 Science Party Personnel

Name	*Institution*	*Position*	*Phone*	*Email*
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Ship's Crew

Sommer, Frederick CAPT
Bateman, Dale CDR
Stewart, Jeffrey CDR
Petrusa, Douglas LCDR
Angelo, James YNC
Appleberry, Jason LT
Ayers, Silas LT
Bartlett, Charles MST1
Baldwin, Robin FS3
Beasley, Corey HSCS
Bender, Zachary ENS
Berringer, Mike ETC
Blas, Paul FN
Brogan, John MKC
Brown, Betty MK3
Buford, Aimee BM2
Coombe, Jeffrey MK2
Dabe, Jeffrey IT1
Davis, Jonathon ET2
Dolton, Peter ENS
Dull, Steven FS2
Dunning, Lara BM3
Fernandez, Chelsey SN
Ford, Angela SN
Galvez, Oscar R. LT
Glenzer, William BM1
Ghosn, Kathleen FN
Gray, Deidre SN
Griffin, Bobby SK2
Hamilton, H. Mark FS3
Harbinsky, Mark ET2
Harris, Daniel SK1
Huneycutt, Gaines BM2
Hurtado, Daniell EM1
Imgarten, Christopher DC1
Irwin, Paul EM2
Jacobs, Bryson ENS
Jones, Greg MKCS
Kidd, Wayne BMC
Kimmel, Brian BM3
Kruger, Thomas MST3
Ladd, Donald EM2
Laisure, Jeremy SK2
Lambert, Douglas MKC
Layman, Rich MST1
Liebrecht, Brian ET1
Lyons, Sean R CWO3
Manangan, Sorjen OSC
Marsden, George DCC
McNally, Terence SK1
McManus, Gene SN
Merten, James SN
Miller, Valerie CWO2
Murphy, Nicholas MK2
Murray, Justin SN
Myatt, Lisa ENS
Olson, James EM3
O'Sullivan, Brandon MK2
Passalacqua, Joseph ETCM
Podhora, Curtis EMCM
Powell, Gregory ET3
Quichocho, Robert MK1
Redd, Davion DC2
Rieg, Mark MSTC
Rivera-Maldonado, Abner SKC
Rodermund, Michael, SA
Rose, John CWO
Roy, Evan BM3
Rudibaugh, Kenneth MK1
Schendorf, Tara ENS
Shaffer, Hans EM1
Siciak, Anthony MK3
Smith, Corey MK3
Smith, Josh LTJG
Starling, Wendy MK2
Swanson, Shawn ET1
Thomas, Tasha ENS
Thompson, Emily SN
Tysin, Alley SNFS
Von Kauffmann, Daniel IT1
Wagner, Alexander FN
Whiting, Allan, MK1
Williams, Tony FSCS
Wilson, Thomas BMCM
Worrell, Kenneth EM1
Yeckley, Andy BM3
Zitting, Arrene FS1

Science Components and their major sampling activities

Auxiliary Science (Healy)

IABP - National Ice Center
Pablo Clemente-Colon (NIC/NOAA)

This effort represents continued participation of NIC personnel and the testing and deployment of International Arctic Buoy Program (IABP) buoys. Drifting buoys will be deployed in open water during the most western and southern tracks of the cruise. None of these deployments should require on ice operations. Although unlikely, depending on need, opportunity, and sea ice conditions encountered, one of the seasonal buoys may instead be deployed on multiyear sea ice (MYI). In this case, the deployment on MYI, if needed, would be scheduled to take advantage of other planned stops but in all cases will be conducted strictly as independent and separate field activities from other cruise plans. Typical deployments on MYI take 30-45 minutes of on-the-ice time. The seasonal buoys testing and deployment should be completed during HLY0805. A pre-cruise nowcast analysis of sea ice conditions in the Beaufort Sea and Canada Basin region will be provided by the NIC to the Chief Scientist. In addition to on board sea ice analysis and imagery cruise support, the NIC personnel will collect hourly observations of sea ice characteristic as the Healy navigates ice infected waters. Recorded observations will include estimates of ice thickness and snow depth during icebreaking operations in the ice pack. NIC personnel will also coordinate with the Louis St. Laurent the acquisition and analysis of satellite imagery from NIC and Canadian Ice Service sources under the North American Ice Service collaboration.

Mixotrophy in Arctic Protists – Alternative Nutritional Strategies
Rebecca J. Gast (WHOI) and Robert Sanders (Temple University)

One-celled plankton traditionally have been divided into either phototrophic (algal, using light for metabolism) or heterotrophic (using complex organic compounds for metabolism). However, mixotrophic behavior, whereby organisms combine both modes of nutrition within a single cell, has been increasingly recognized and documented in recent decades. The potential nutritional benefits of being able to use chemosynthesis as well as particle ingestion gives greater survival potential to the phytoplankton, by enabling it to utilize potential diverse sources of energy, major nutrients, and micronutrients including vitamins and trace metals during long periods of polar darkness when chemosynthesis is not practical. This science experiment involves taking water samples in the Arctic to test for the presence of mixotrophic one-celled organisms. The participating scientists have conducted numerous studies of mixotrophy off Antarctica and are unaware of similar studies in the Arctic.

Water samples are to be collected via CTD equipped with the 24-place rosette with 12L Niskin bottles and silicone O-rings, Chelsea fluorometer, and PAR sensor. Optimally, water is to be collected about every other day (so about 12-13 casts total), at the near surface (5m) and the chlorophyll maximum (around 20-30m in the Antarctic). The samples are cultured, and examined microscopically for evidence of mixotrophy

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.

The data is distributed on a small USB disk drive.

***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 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:

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

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 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.

1_Minute_Averaged_Data:

HLY0806_distance.csv.gz	Distance along track from port.
HLY0806_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:

/aft_a_frame	Wire tension, wire out, and wire speed for the Aft A frame sheaves.
/air_temp_f	Temperature data from the RM Young wind sensor in Fahrenheit. Data is derived from data from files in the rmyoung_air directory
/ashtech_attitude	Attitude in NMEA format from the Ashtech ADU5 GPS receiver
/ashtech_gga	Position data in NMEA GGA format from the Ashtech ADU5 GPS receiver
/ashtech_gll	Position data in NMEA GLL format from the Ashtech ADU5 GPS receiver

/ashtech_hdt	Heading data in NMEA HDT format from the Ashtech ADU5 GPS receiver
/dew_point_f	Dew point temperature derived from air temp
/flomet_a	Flow meter data just upstream of the A TSG and Fluorometer.
/fluro_a	Flurometer for the A TSG sensor.
/glonass_gga	Position data in NMEA GGA format from the GLONASS GPS receiver.
/glonass_gll	Position data in NMEA GLL format from the GLONASS GPS receiver.
/gyro_mk27	Heading data in NMEA HDT format from the Sperry MK27gyro compass
/gyro_mk39	Heading data in NMEA HDT format from the Sperry MK39 gyro compass
/ibs_waypoints	Waypoints from the Healy's Integrated Bridge System
/isus	ISUS Nitrate Sensor small file
/isus3v	ISUS Nitrate Sensor 3V full file
/knudsen	Depth data in the Knudsen PKEL format received from Knudsen 320 B/R serial output
/met3a_sen	Meteorology data from the top of the Jack Staff on the bow.
/oxygen_a	Dissolved oxygen values from A TSG.
/pcode_aft_gga	Position data in NMEA GGA format from the Trimble Centurion P-Code GPS receiver located in the Computer Lab
/pcode_aft_gll	Position data in NMEA GLL format from the Trimble Centurion P-Code GPS receiver located in the Computer Lab
/pcode_aft_vtg	Course made good and speed over ground in NMEA VTG format from the Trimble Centurion P-Code GPS receiver located in the Computer Lab
/pcode_aft_zda	Time and date data in the NMEA ZDA format from the Trimble Centurion P-Code GPS receiver located in the Computer lab
/pcode_bridge_gga	Position data in NMEA GGA format from the Trimble GPS receiver located on the bridge.
/pcode_bridge_gll	Position data in NMEA GLL format from the Trimble GPS receiver located on the bridge.
/pcode_bridge_vtg	Course and speed over ground data in NMEA VTG format from the Trimble GPS receiver located on the bridge.
/posmv_gga	Position data in NMEA GGA format from the POS/MV
/posmv_gst	Pseudorange error statistics in NMEA GST format from the POS/MV
/posmv_hdt	Heading data in NMEA HDT format from the POS/MV
/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 POS/MV
/posmv_zda	Time and date data in NMEA ZDA format from the POS/MV
/pressure_sen	Water pressure in the Uncontaminated Seawater System in the Bio Chem Lab in pounds per square inch.

/rmyoung_air	Temperature, relative humidity, and atmospheric pressure in NMEA format from the RM Young meteorological system on the bridge and flying bridge.
/rmyportwind	Wind speed and direction data in NMEA format from the RM Young weather vane on the port side of the Healy.
/rmystbdwind	Wind speed and direction data in NMEA WMV format from the RM Young weather vane on the starboard side of the Healy.
/samos_data	Derived (assembled) meteorology data reported automatically during the cruise for SAMOS.
/sbd_a_frame	Wire tension, wire out, and wire speed for the starboard A frame sheaves.
/seabeam_center	Center depth extracted in real-time from the SeaBeam 2112
/solar_radiometers	Short wave and long wave solar Radiometer data from sensors on the top of HCO.
/sperry_speedlog	Ground/water speed data from the Sperry SRD-500 Speed Log. The speed log is retracted and not operated when the ship is operating in ice.
/surface_par	Photosynthetic Active Radiation volts and microeinstens/m^2 from the surface PAR sensor on the top of HCO.
/sv2000	Speed of sound in the water/propelyene glycol solution as measured by the SV2000 acoustic velocimeter located in the ADCP BB150 sonar well
/true_wind_port	True wind speed calculated by SCS from gyro heading (source undefined) and the port-side RM Young windbird
/true_wind_stbd	True wind speed calculated by SCS from gyro heading and the starboard-side RM Young windbird.
/winch_data	Wire data (line out, tension and wire speed) from the Totco wire metering ssystem.
/wind_sen_a	Wind data from the ultrasonic anemometer on the Jack Staff.
/wind_sen_b	Wind data from the the ultrasonic anemometer on the starboard yard arm (of the mast.)

Extra files in the directory SCS_Data:

ACQLOG.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:

/AloftConCam	Contains photographs (images) in JPEG format from the digital camera mounted in Aloftcon and pointed forward. Picture files are grouped in

	subdirectories by folders by Day of Year (YYYYJJJ). The picture files are in 5 minute JPEG format.
/FantailCam	Photographs from a digital camera mounted in AftCon and pointed at the fantail/stern A-frame. Same structure as the AloftCon photos but not at the same resolution.
/adu5	Contains the data from the Thales (Ashtech) ADU5 GPS Receiver whose antenna array is mounted on the top of HCO..
/aggps	Contains the data from the Trimble AG132 differential GPS Receiver. Antenna is on the top of HCO..
/ais	Contains data from the Automatic Identification System (AIS) receiver mounted on the top of HCO. These are binary messages encapsulated in NMEA VDM sentences.
/bgm221	Contains the data from the Bell BGM-3 Marine Gravity meter system serial number 221 installed in IC/Gyro.
/bgm222	Contains the data from the Bell BGM-3 Marine Gravity meter system serial number 222 installed in IC/Gyro..
/events	Contains the LDS event log for each logging process. Typically a record for each time that process was started plus any other messages.
/mk27	Contains the data from the ship's Sperry MK27 Gyrocompass
/mk30	Contains the data from the ship's Sperry MK30 Gyro.
/posatt	Contains the attitude data from the POSMV GPS aided inertial guidance, heading and attitude reference system.
/posnav	Contains the navigation data records in NMEA format from the POSMV GPS.
/posreform2sb	Contains the navigation data from the POSMV GPS reformatted in real-time for the SeaBeam 2112 multibeam sonar.
/sbctr	Contains the center beam data in NMEA format extracted from the SeaBeam 2112 data.
/sbsv	Contains the surface sound speed calculated in real-time from the TSG records and formatted for the SeaBeam.
/seabeam	Contains the raw SeaBeam 2112 multibeam data. These data are in MB-System Type 41 format which is the native format of the sonar.
/tsg_met	Contains the all data from the TSG and Met sensors installed and supported by the Ocean Data Facility (ODF) of the Scripps Institution of Oceanography (SIO).
/SwapPingHLY	Contains network performance statistics (from 'ping ')for the Healy/LSSL SWAP2 wireless network connection.
/SwapRoute	Contains routing table information for Healy/LSSL SWAP2 wireless network connection.
/SwapStatsHLY	Contains Healy wireless stats for Healy/Louis wireless network(swap) connection.
/SwapStatsLSL	Contains Louis wireless stats for Healy/Louis wireless network(swap) connection.

Raw:

/adcp75	The VMDAS native-format data for the RDI OS75 KHz ADCP data
/adcp150	The VMDAS native format data for the RDI VM150 Acoustic Doppler Profiler (ADCP) 150 KHz
/ctd	CTD data in directories by Cast number.
/xbt	Expendable Bathythermograph data in raw (RDF) and export (EDF) formats.
/knudsenraw	Data from the Knudsen 320B/R chirp subbottom profiler.

Satellite_Images:

	Contains satellite imagery in jpeg format
/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:

/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 Seabeam

Plots:

./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.
./surface_daily_plots	Directories containing daily plots of under way data.

Contents by directory:

SCS_Data:

aft_a_frame
air_temp_f
ashtech_attitude
ashtech_gga
ashtech_gll
ashtech_hdt
dew_point_f
flomet_a
fluro_a
glonass_gga
glonass_gll
gyro_mk27
gyro_mk39
ibs_waypoints
isus
knudsen
met3a_sen
oxygen_a
pcode_aft_gga
pcode_aft_gll
pcode_aft_vtg
pcode_aft_zda
pcode_bridge_gga
pcode_bridge_gll
pcode_bridge_vtg
posmv_gga
posmv_gst
posmv_hdt
posmv_pashr
posmv_vtg
posmv_zda
rmyoung_air
rmyportwind
rmystbdwind
samos_data
seabeam_center
solar_radiometers
sperry_speedlog
stbd_a_frame
surface_par
surface_temp
sv2000
true_wind_port
true_wind_stbd
tsg_a
wind_sen_a
wind_sen_b

Raw:

adcp150
adcp75
ctd
knudsenraw
xbt

***Satellite*_Images:**

dmsp
hrpt

LDS_Data:

AloftConnCam
FantailCam
SwapPingHLY
SwapRoute
SwapStatsHLY
SwapStatsLSL
adu5
aggps
ais
bgm221
bgm222
events
mk27
mk30
posatt
posnav
posreform2sb
sbctr
sbsv
seabeam
tsg_met

Meta_Data:

Bridge_Logs
Systems_Calibration_Data
Elog
WHOisWHO
Sensor_Formats

Plots:

Knudsen_hourly_plots
Surface_daily_plots

SVP:

1_Minute_Averaged_Data:

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 around 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.

HLY0806_track.csv

16945,2008/09/17 02:56,79.4979640,-140.5858535,108.9,3.4,115.4,3786.4,-1.313,-0.801,21.6495,26.034,0.474,0.047,0.000,0.010,2.77,11.98,320.65,271.60,271.58,34.78,-1.82,98.20,1019.26,5.01,143.96,4.36,267.71,5.94,129.06,4.07,258.55,5.46,7.350,-0.801,,,1,-20,8,0,1,-20,8,0,11.91,263.1,8.72,1.37
16946,2008/09/17 02:57,79.4976388,-140.5811450,112.1,3.3,119.0,3785.6,-1.311,-0.802,21.6451,26.029,0.482,0.048,0.000,0.010,2.77,11.98,320.57,271.60,271.58,34.78,-1.82,98.20,1019.23,5.02,144.36,5.54,270.33,7.07,121.20,3.88,255.88,5.10,7.352,-0.802,,,1,-20,8,0,1,-20,8,0,12.46,259.4,8.72,1.36
16947,2008/09/17 02:58,79.4972918,-140.5765272,112.7,3.3,119.3,3781.4,-1.310,-0.803,21.6409,26.024,0.478,0.048,0.000,0.010,2.77,11.98,320.64,271.59,271.57,34.34,-1.83,98.18,1019.20,5.02,148.16,5.97,272.92,7.51,132.40,4.11,264.42,5.51,7.352,-0.803,,,1,-20,8,0,1,-20,8,0,13.82,265.1,8.72,1.36

Field	***Data***	***Example***	***Units***
01	ID	16945	sample count
02	date	2008/09/17 02:56	date & time UTC (year/month/day hour:minute)
03	lat	79.4979640	$INGGA, POSMV Latitude (decimal degrees)
04	lon	-140.5858535	$INGGA, POSMV Longitude (decimal degrees)
05	cog	108.9	$INVTG, POSMV Course Over Ground (angular distance from 0 (North) clockwise through 360, 1 minute average)
06	sog	3.4	$INVTG, POSMV Speed Over Ground (Knots, 1 minute average
07	heading	115.4	$PASHR, POSMV ship heading(angular distance from 0 (North) clockwise through 360, 1 minute average)
08	depth	3786.4	$SBCTR, Seabeam centerbeam depth(meters, 1 minute average)
09	SST	-1.313	$PSSTA, SBE3s RemoteTemperature, Sea Chest intake (Celsius, 1 minute average)
10	TSG_InTemp	-0.801	$PSTSA, SBE45 internal temperature (Celsius, 1 minute average)
11	TSG_Cond	21.6495	$PSTSA, SBE45 Water Conductivity (millisiemens/centimeter, 1 minute average)
12	TSG_Sal	26.034	$PSTSA, SBE45 Water Salinity (PSU, 1 minute average)
13	SCF-FL	0.474	$PSFLA, SCF Fluorometer (Ug/l, 1 minute average)
14	SCF-FL-V	0.047	$PSFLA, SCF Fluorometer (Volts, 1 minute average)
15	SCF-Turb	0.000	$PSFLA, SCF Turbidity (NTU, 1 minute average)
16	SCF-Turb-V	0.010	$PSFLA, SCF Turbidity (Volts, 1 minute average)

Field	Data	Example	Units
17	tsg_flow_A	2.77	$PSFMA, Flowmeter in-line with PSTSGA, PSOXA, PSFLA (LitersPerMinute, minimum value in 1 minute interval)
18	SWR	11.98	$PSSRA, Short Wave Radiation (W/M^2, 1 minute average)
19	LWR	320.65	$PSSRA, Long Wave Radiation (W/M^2, 1 minute average)
20	LWR_Dome_T	271.60	$PSSRA, LWD Dome Temperature (Deg K, 1 minute average)
21	LWR_Body_T	271.58	$PSSRA, LWD Body Temperature (Deg K, 1 minute average)
22	PAR	34.78	$PSSPA, Surface PAR (uE/Sec/M^2, 1 minute average)
23	MET3A_Temp	-1.82	$PSMEA, MET3A Air Temperature (Deg C, 1 minute average)
24	MET3A_RH	98.20	$PSMEA, MET3A Relative Humidity (%, 1 minute average)
25	MET3A_Baro	1019.26	$PSMEA, MET3A Barometric Pressure (millibars, 1 minute average)
26	MET3A_Precip	5.01	$PSMEA, MET3A Precipitation (mm, 1 minute average)
27	JS_WndDirR	143.96	$PSWDA, Jackstaff Relative wind direction (deg, 1 minute average)
28	JS_WndSpdR	4.36	$PSWDA, Jackstaff Relative wind speed (m/s, 1 minute average)
29	JS_WndDirT	267.71	$PSWDA, Jackstaff True wind direction (deg, 1 minute average)
30	JS_WndSpdT	5.94	$PSWDA, Jackstaff True wind speed (m/s, 1 minute average)
31	MM_WndDirR	129.06	$PSWDB, Main Mast Relative wind direction (deg, 1 minute average)
32	MM_WndSpdR	4.07	$PSWDB, Main Mast Relative wind speed (m/s, 1 minute average)
33	MM_WndDirT	258.55	$PSWDB, Main Mast True wind direction (deg, 1 minute average)
34	MM_WndSpdT	5.46	$PSWDB, Main Mast True wind speed (m/s, 1 minute average)
35	SBE_Oxy	7.350	$PSOXA, SBE-43 Oxygen(ml/l, 1 minute average)
36	SBE_Oxy_T	-0.801	$PSOXA, SBE-43 Oxygen Temperature(Deg C, 1 minute average)
37	Isus_1		$PSNTA, Isus Aux 1(Volts, 1 minute average)
38	Isus_2		$PSNTA, Isus Aux 2(Volts, 1 minute average)
39	WinchAft	1	Aft A-Frame Winch number
40	TensionAft	-20	Aft A-Frame Winch Wire tension(Pounds, 1 minute average)
41	WireOutAft	8	Aft A-Frame Winch Wire out (Meters, 1 minute average)
42	SpeedAft	0	Aft A-Frame Winch Wire speed (Meters/minute, 1 minute average)
43	WinchSbd	1	Starboard A-Frame Winch number
44	TensionSbd	-20	Starboard A-Frame Winch Wire tension (Pounds, 1 minute average)
45	WireOutSbd	8	Starboard A-Frame Winch Wire out (Meters, 1 minute average)
46	SpeedSbd	0	Starboard A-Frame Winch Wire speed (Meters/minute, 1

Field	Data	Example	Units
			minute average)
47	StbdWndSpdT	11.91	RM Young True Wind Speed, starboard (Knots, 1 minute average)
48	StbdWndDirT	263.1	RM Young True Wind Direction, starboard (angular distance from 0 (North) clockwise through 360, 1 minute average)
49	OxySat	8.72	Dissolved oxygen (DO) saturation as a function of T and S (Weiss)(ml/L, 1 minute average)
50	AOU	1.37	Apparent Oxygen Utilization (AOU)(ml/L,1 minute average)

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 HLY0806_Sensors. This is now a separate document due to its large size. The file HLY0806_Sensors.htm is found in the Meta_Data directory. A PDF version of this file should also be here. To use this html file you will need to have the directory HLY0806_Sensors_files in the same directory as the html file.

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

APPENDIX:

Acquisition Problems and Events

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 of entries by the science party watchstanders. 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.

Date	***Time (UTC)***	***Comment***
09/05/08	09:17	Start Knudsen for HLY0806
09/06/08	04:00	Start SeaBeam for HLY0806
09/06/08	16:21	Start ADCP 150 for HLY0806
09/07/08	00:30	Start ADCP 75 for HLY0806
09/07/08	21:09	Adjust flow rate for Science Seawater
09/08/08	20:17	Load codes into P-Code GPS
09/09/08	06:20	Note at about 10Z 9/8/8 the Jack Staff and Yard Arm Ultrasonics rime iced
09/09/08	17:21	WDS system configured to encrypted mode
09/13/08	02:38	Port side Ship's wind bird frozen for the last few days
09/13/08	02:45	Ship to ship SWAP came up today
09/13/08	05:22	SeaBeam stopped ½ hour ago, investigating
09/13/08	05:55	SeaBeam running again with new MO disk
09/18/08	03:27	Gravimeter 221 failed around 00:00 UTC
09/18/08	11:03	Around 01:30Z the winds sensors look like they are mostly working again
09/18/08	23:05	Attempt Gravimeter 221 restart 15 minutes ago
09/19/08	21:38	ice in Biochem sink, TSG flow clogged. MST water flow tests
09/19/08	23:58	TSG flow rate at about 2.5 l/m
09/20/08	03:29	TSG was getting various tests with water flowing on the bow (see notes)
09/22/08	07:07	on 9/21 at 21:04Z ADCP 75 was secured to get cleaner 150 data.
09/22/08	07:14	ADCP 150 gyro input locked
09/22/08	07:40	ADCP 150 gyro reset
09/22/08	12:45	SCS display adjusted. SCS restarted??
09/22/08	15:10	ADU5 Attitude stopped at about 18Z on 9/19
09/22/08	16:35	ADU5 Attitude reset
09/23/08	07:04	ADCP 150 gyro input locked
09/23/08	07:16	ADCP 150 reset
09/25/08	03:33	Gravimeter roll gyro replaced and restarted
09/25/08	16:47	Saltwater flow adjusted
09/25/08	16:57	Earlier Gyro MK27 failed. Reset and up again
09/25/08	19:35	Various TSG tests conducted over the day
09/28/08	00:16	Maybe a restart of some SeaBeam serial console windows?
09/28/08	09:02	AU5 heading stopped at 21:00Z the previous day, contact ECC
09/28/08	09:11	AU5 reset heading working again
09/29/08	07:52	SeaVenture crashed. Links to other computers re-established
09/29/08	21:20	VMS was taken down without notice. SeaBeam time thrown off.
10/01/08	05:46	ADCP 150 stopped. End of HLY0806 data.
10/01/08	05:47	ADCP 75 stopped. End of HLY0806 data.
10/01/08	05:51	Knudsen stopped. End of HLY0806 data.
10/01/08	06:02	SCS recording stopped. End of HLY0806 data.
10/01/08	06:07	LDS recording stopped. End of HLY0806 data.

Comments that might help when using the 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 directories. The data may have been recorded there.

The Knudsen data written into SCS_Data/Knudsen has an inconsistent time in the data. The time that the SCS writes to the start of the KEA 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 KEA records.

The SeaBeam data is raw and unedited. This data may need significant editing and care depending on the intended use. The SeaBeam 2112 has significant 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 2112 installations than those installed on non-icebreakers.. The acoustic noise plus bubble-sweep down and masking by ice 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 (3- to 60 degrees), because of it's bottom detection algorithm and because it penetrates the seafloor.

Both the mechanical windbirds and the ultrasonic anemometers spent much of the trip iced up. Care should be taken when using the data from the wind sensors. Although the ultrasonic anemometers are heated, it seems like there amount of heat was not up to the task.

Part way into the cruise the Gravimeter #221 failed. This was fixed and the meter was restarted. There is a difference in offset of the raw counts compared to the #222 Gravimeter after the restart. Care should be taken when using this data until calibrations have been completed.

During the cruise at various times the MSTs were changing the water flow in the Science Sea Water system to test the system's response to various flow rates in the ice. This changes the amount of water going through the TSG and has discernable impact on the dissolved oxygen measurement among other things. You should closely follow the elog entries for the TSG to see when water flow rates were adjusted. These events were not always accurately entered into elog.

In the SVP directory are the sound speed proviles use for the SeaBeam. These are constructed from various sources including XBTs, historical data (the Levitus climatology), CTDs and from the XCTDs deployed from LSSL. These files were created from the full XCTD data, which is proprietary. The Sound Speed Profiles used are entered into the SeaBeam. When the MO crashes, the SVP's used are not preserved and need to be transferred to the new MO disk. The SVP directory has many of the SVPs used but not all of them.

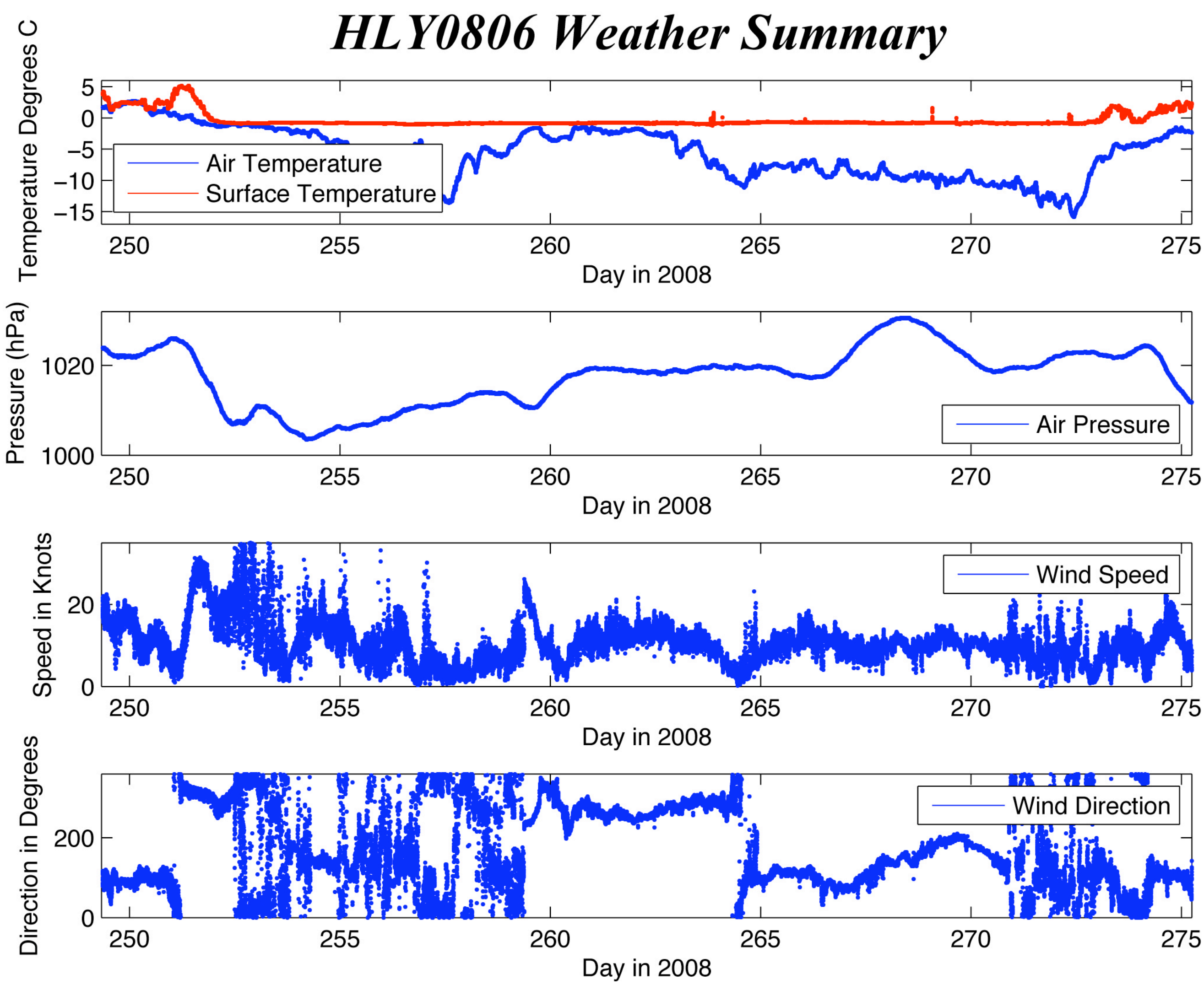
The ADCP file naming uses a series number after a base name. Below is a summary of the dates and the series numbers used for this cruise for each ADCP. Details of events that affect the ADCP data recording were logged in both the Technicans' and the Watch Standers' electronic logs for HLY0806.

ADCP Operational summary:

150Khz Broadband		***75KHz Narrowband***	
HLY0806001*	09/06 - 09/16	HLY0806001*	09/06 - 09/21
tests			
HLY0806002-4*	09/16		
		turned off to check interference on 150	09/21
New configuration w/ low exclusion thresholds			
HLY0806005*	09/16 - 09/24		
System hung, had to restart			
HLY0806006*	09/24 – 09/28		
		turned back on	
		HLY0806002*	09/26 -
Trouble restarting, several tries to start			
HLY0806007-11*	09/28 -		

The POSMV navigation system reports it's location as the master reference point and not at the antenna locations above the Helicopter Control Shack (HCO). The Location of the Master Reference Point (MRP) can be seen in the diagram at the end of this document showing instrument locations on the ship.

Cruise Weather Summary



Underway Sensors and Calibrations

Sensors and Calibrations

HLY0806 Shipboard Sensors

Sensor	Description	Serial #	Last Calibration Date	Status
Meteorology & Radiometers				
Port Anemometer	RM Young 09101	L001	02/06/07	Collected
Stbd Anemometer	RM Young 09101	L003	03/07/07	Collected
Barometer	RM Young 612011	BP01643	02/22/08	Collected
Air Temp/Rel. Hum.	RM Young 41382V	13352	02/22/08	Collected
Helo shack PAR	BSI QSR-2200	20270	01/09/07	Collected
Shortwave Radiation	Eppley labs - PSP	35032F3	08/01/07	Collected
Longwave Radiation	Eppley labs - PIR	34955F3	08/17/07	Collected
Barometer	Paroscientific MET3A	101757	06/27/07	Collected
Bow Temperature	Paroscientific MET3A	101757	06/27/07	Collected
Precipitation	Paroscientific MET3A	101757	06/27/07	Collected
Relative Humidity	Paroscientific MET3A	101757	06/27/07	Collected
Jack Staff Ultrasonic Anemometer	RM Young 85004	00703	09/20/07	Collected
Yard Arm Stb Ultrasonic Anemometer	RM Young 85004	00704	09/20/07	Collected
Underway Ocean				
TSG A	SeaBird SBE45	0215	08/01/07	Collected
Remote Sea Temp	SeaBird SBE3S	4063	12/13/07	Collected
Fluorometer A	Seapoint SCF	SCF2957	12/15/07	Collected
Oxygen Sensor A	SeaBird SBE-43	1307	09/28/07	Collected
Flowmeter A	Flocat C-ES45-B003	09061005	01/07/08	Collected
AC-S Spectral Attenuation and Absorption Meter	Wetlabs	053	010/10/8	Colected
Sonars				
Knudsen- subbottom	320 B/R	K2K-00-0013	N/A	Collected
ADCP 150 kHz	Broad Band (BB150)	80	N/A	Collected

Sensor	Description	Serial #	Last Calibration Date	Status
ADCP 75 kHz	Ocean Surveyor	172	N/A	Collected
Multibeam	Seabeam 2112	?	N/A	Collected
Speed log	Sperry	?	N/A	Collected
Navigation				
P-Code GPS (aft)	Trimble Centurion	0220035469	N/A	Collected
Attitude GPS	Ashtech ADU5	AD520033513	N/A	Collected
DGPS	Trimble AGGPS-AG132	0224016199	N/A	Collected
POSMV	Model- MV V4	2306	N/A	Collected
P-Code GPS (fwd)	Rockwell	?	N/A	Collected
Glonass GPS	?	?	N/A	Collected
GYRO 1	Sperry MK39 Mod 3A PN 03956-1982416-2	340	?	Collected
GYRO 2	Sperry MK27A 4800880-1	025	N/A	Collected

HLY0806- CTD Sensors

Sensor	Comments	Serial #	Last service/ Calibration Date	Status
CTD sensor	SBE 911plus	639	01/18/08	
Pressure Sensor #1	Digiquartz with TC	83012	01/18/08	Collected
Temperature #1	SBE3- Primary	2855	01/21/08	Collected
Temperature #2	SBE3- Secondary	2796	01/27/08	Collected
Temperature #3	SBE 35	0011	03/08	Collected
Conductivity #1	SBE4- Primary	2568	01/18/08	Collected
Conductivity #2	SBE4- Secondary	2561	01/18/08	Collected
Pump	SBE5 Primary	3115	01/08	NA
Pump	SBE5 Secondary	3112	01/08	NA
Deck Unit	SBE 11-Plus V2	0417	12/07	NA
Altimeter	PSA916	843	01/08	Collected
Oxygen	SBE43	458	12/12/07	Collected
Fluorometer	Chelsea-Aquatrack3	088234	03/07	Collected
Transmisometer	Wetlabs	CST-390DR	01/08	Collected
PAR	Bioshperical QSP2300	70115	01/07	Collected
Carousel	SBE32- 12 place	347	01/08	NA

HLY0806 Sensor Calculations

The coefficients for temperature, conductivity, fluorometer and turbidity sensors can be found in the calibrations sheets below in the Appendix.

Calculating Temperature – ITS-90

- T = decimal equivalent of bytes 1-4
- Temperature Frequency: f = T/19 +2100
- Temperature = $1/\{g + h[\ln(f_0/f)] + i[\ln^2(f_0/f)] + j[\ln^3(f_0/f)]\} - 273.15$ (°C)

Calculating Conductivity – ITS-90

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

Calculating Fluorometry Voltage

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

Calculating Transmittance

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

Calculating PAR for surface PAR

- raw data = mV
- calibration scale = 6.08 V/(μEinstiens/cm ^{2}sec)
- offset (V_{dark}) = 0.3 mV
- (*raw* mV - V_{dark})/scale x 10^4 cm^2/m^2 x 10^{-3} V/mV= μEinstiens/m^2sec
- or
- (*data* mV – 0.3 mV) x 1.65 (μEinstiens/m^2sec)/mV = μEinstiens/m^2sec

Calculating Pyrgeometer Values

V = Eppley PIR Thermopile voltage

S = Sensitivity (Calibration factor from Eppley Cal sheet)

S = 3.32

J = Stefan-Boltzmann Constant

J = 5.6697e-8

B = [absorption constant (for Eppley Black paint formula) 0.985 / dome glass IR transmission 0.5]

B= 3.5 for Stock Eppley PIR

Tb = Eppley Body Temperature in degrees Kelvin

Td = Eppley Dome Temperature in degrees Kelvin

Tb and Td calculated as follows:

T = 1/ (a + ln(Vo/Irt)*(b + c*(ln(Vo/Irt)**2)));

Irt = (Vref-Vin)/R1

On Healy R1 = 82500 Vref = 5.0

a= 0.0010295 b= 0.0002391 c = 1.568e-7

$$W/M2 = V/S + (J * Tb^4) + (B*J*(Tb^4 - Td^4))$$

Calibrations

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

Meteorology & Radiometers

R.M. Young Wind Bird, Starboard

Serial # L001

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

R.M. Young Wind Bird Port

Serial # L001

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

Barometer

Serial # BP01643

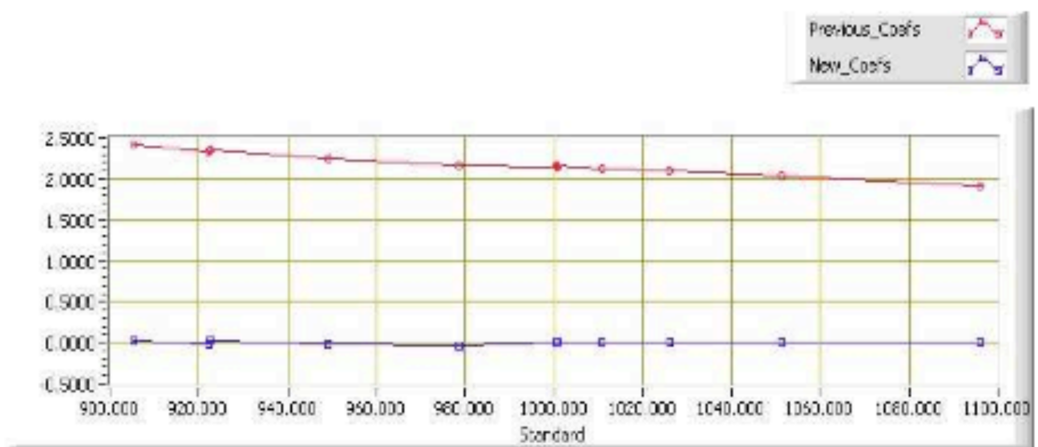
Baro Pres Calibration Report
STS/ODF Calibration Facility

SENSOR SERIAL NUMBER: BP01643
CALIBRATION DATE: 22-Feb-08
SENSOR ID: BPR80
Mfg: RM Young   Model: 612011
Previous Cal Date: 01-Jan-00
Calibration Tech: CM
CALIBRATION AT 25.0 DegC

A= 5.98528E+1
B= 8.02635E+2

Calibration Standard: Mfg: Paroscientific   Model: 765-16B   s/n: 101778
Polynomial Order = 1
Xcalc = A*X+B

SENSOR VOLTS	STANDARD DATA	SENSOR New_Coefs	SPRT-INST Prev_Coefs	SPRT-INST New_Coefs
4.901	1095.960	1095.953	1.920	0.007
4.151	1051.090	1051.086	2.028	0.004
3.731	1025.970	1025.963	2.092	0.007
3.475	1010.640	1010.645	2.118	-0.005
3.306	1000.490	1000.479	2.159	0.011
3.314	1000.990	1000.986	2.151	0.004
2.939	978.480	978.517	2.165	-0.037
2.445	948.980	949.001	2.254	-0.021
2.004	922.570	922.555	2.355	0.015
1.998	922.190	922.205	2.326	-0.015
1.713	905.210	905.180	2.413	0.030



Air Temperture / Relative Humidity

Serial # 13352

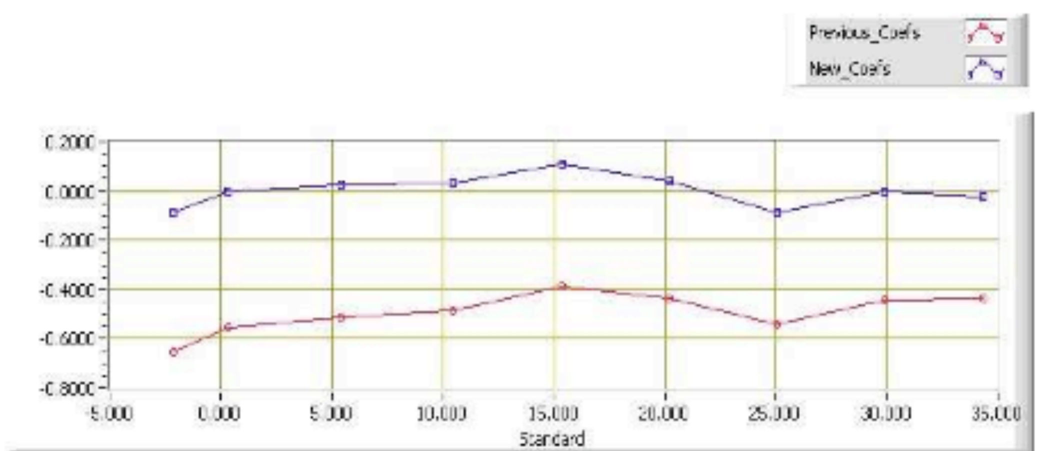
Air Temperature Calibration Report
STS/ODF Calibration Facility

SENSOR SERIAL NUMBER: 13352
CALIBRATION DATE: 22-Feb-08
SENSOR ID: HRH17
Mfg: RM Young   Model: 41382V
Previous Cal Date: 01-Jan-2000
Calibration Tech: CM

A= 1.01413E+2
B= -5.07642E+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
0.480	-2.122	-2.035	-0.652	-0.087
0.504	0.337	0.338	-0.557	-0.001
0.554	5.421	5.398	-0.513	0.023
0.603	10.448	10.418	-0.485	0.030
0.651	15.345	15.235	-0.386	0.110
0.699	20.190	20.154	-0.439	0.036
0.748	25.029	25.113	-0.539	-0.084
0.796	29.914	29.920	-0.442	-0.006
0.840	34.361	34.382	-0.439	-0.021



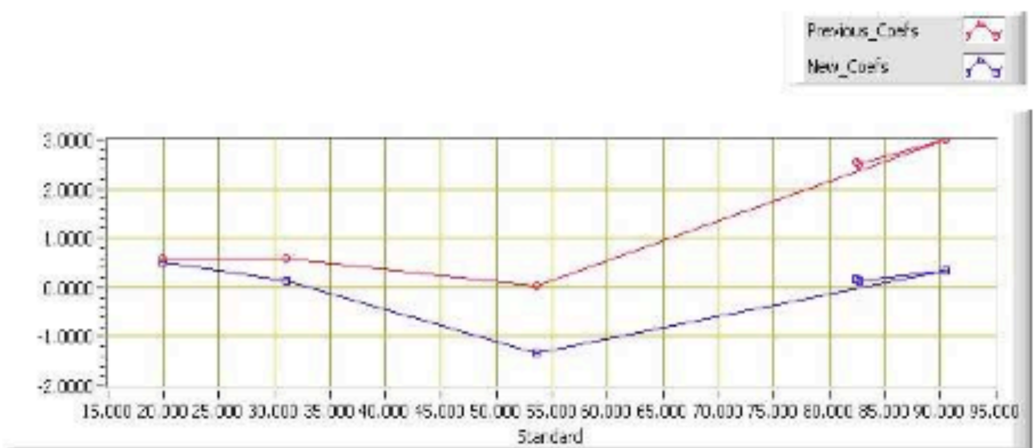
HUMIDITY Calibration Report
STS/ODF Calibration Facility

SENSOR SERIAL NUMBER: 13352
CALIBRATION DATE: 24-Feb-08
SENSOR ID: HRH17
Mfg: RM Young   Model: 41382V
Previous Cal Date: 01-Jan-2000
Calibration Tech: CM

A= 1.04836E+2
B= -6.79727E-1

Calibration Standard: Mfg: GE Sensing   Model: Humilab   s/n: 0240507
Polynomial Order = 1
Xcalc = A*X+B

SENSOR	STANDARD DATA	SENSOR New_Coefs	SPRT-INST Prev_Coefs	SPRT-INST New_Coefs
0.791	82.450	82.266	2.539	0.184
0.794	82.710	82.560	2.516	0.150
0.866	90.460	90.108	2.994	0.352
0.530	53.570	54.904	0.020	-1.334
0.301	31.000	30.876	0.599	0.124
0.192	19.920	19.396	0.579	0.524



PAR

Serial # 20270

Biospherical Instruments Inc.

CALIBRATION CERTIFICATE

Calibration Date	1/9/2007
Model Number	QSR-2200
Serial Number	20270
Operator	TPC
Standard Lamp	F-863
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	95.87	mV
Probe Dark	1.32	mV
Probe Net Response	94.55	mV

Corrected Lamp Output:

Output In Air (same condition as calibration):

9.43E+15 quanta/cm²sec
0.01566 uE/cm^{2}sec

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

Dry: 1.00E-17 V/(quanta/cm²sec)
6.04E+00 V/(uE/cm^{2}sec)

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

QSR240R 05/24/95

Shortwave Radiation Pyranometer

Serial # 35032F3

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:

8.35 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:
UCSD/SIO
La Jolla, CA

Date of Test: July 5, 2007

In Charge of Test: R.T. Egeman

S.O. Number: 61245
Date: August 1, 2007

Reviewed by: Thomas D Kirk

Remarks:

Longwave Radiation Pyrgeometer

Serial # 34955F3

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 INFRARED RADIOMETER Model PIR

Serial Number: 34955F3

Resistance: 708 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 25°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:

3.32 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 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/SIO
La Jolla, CA

S.O. Number: 61272
Date: August 17, 2007

Date of Test: May 31, 2007

In Charge of Test: R.T. Egeman

Reviewed by: Thomas Kirk

Remarks:

Jack Staff MET Station

Serial # 101757

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
Address : 8825 Biological Grade
La Jolla, CA 92037 USA

Report Date: 27-Jun-07
Sales Order: 24387
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:	RHTB94	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: [signature] DATE 6-27-07

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

Underway Ocean Flow through Sensors

Seabird ThermoSalinograph

Serial # 0215

Temperature

SEA-BIRD ELECTRONICS, INC.

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

SENSOR SERIAL NUMBER: 0215
CALIBRATION DATE: 01-Aug-07

SBE 45 TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

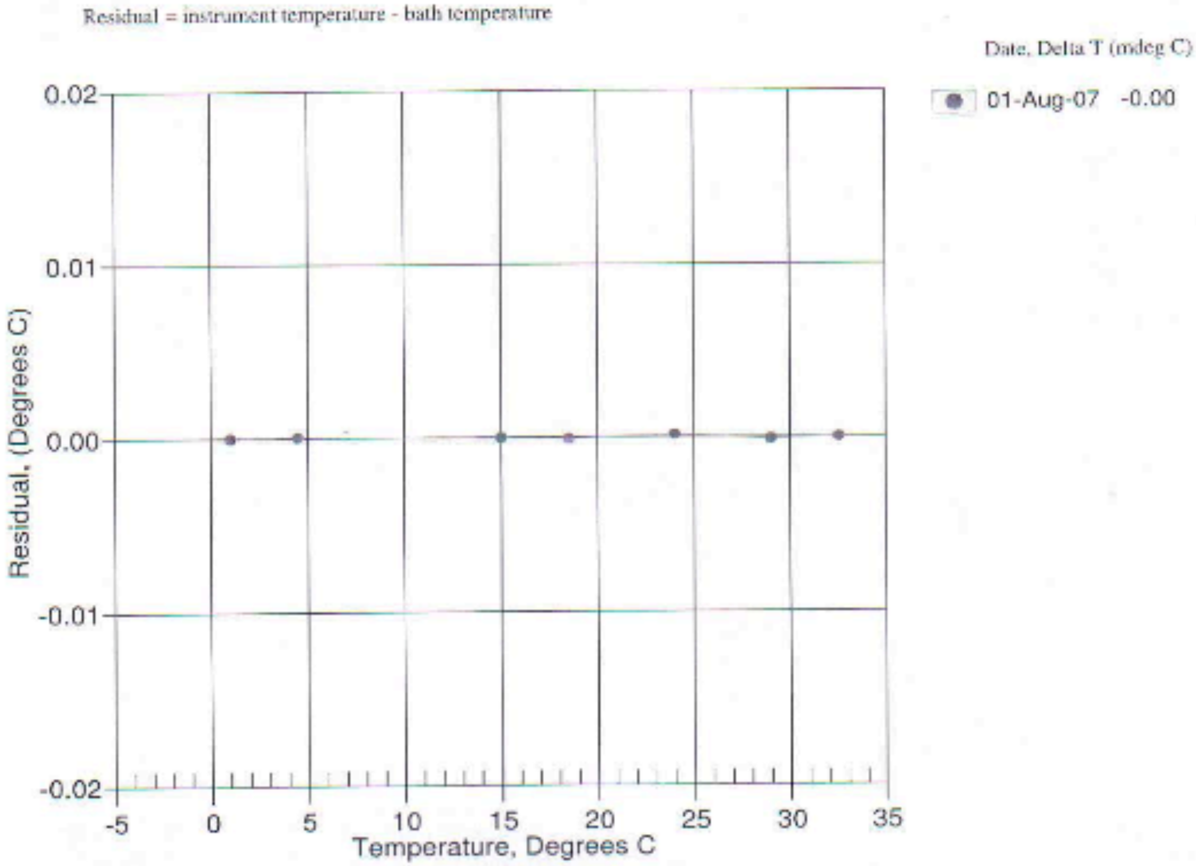
ITS-90 COEFFICIENTS

a0 = -1.277283e-006
a1 = 2.800988e-004
a2 = -2.767325e-006
a3 = 1.635307e-007

BATH TEMP (ITS-90)	INSTRUMENT OUTPUT	INST TEMP (ITS-90)	RESIDUAL (ITS-90)
1.0000	657810.8	0.9999	-0.0001
4.5000	562392.3	4.5000	0.0000
15.0000	358324.1	14.9999	-0.0000
18.5001	310251.4	18.5000	-0.0001
24.0000	248855.2	24.0001	0.0002
29.0001	204884.7	29.0000	-0.0001
32.4999	179404.2	32.5000	0.0000

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

Residual = instrument temperature - bath temperature



Conductivity

SEA-BIRD ELECTRONICS, INC.

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

SENSOR SERIAL NUMBER: 0215
CALIBRATION DATE: 01-Aug-07

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

COEFFICIENTS:

g = -9.817728e-001
h = 1.408375e-001
i = -1.671624e-004
j = 3.431539e-005

CPcor = -9.5700e-008
CTcor = 3.2500e-006
WBOTC = 2.4202e-005

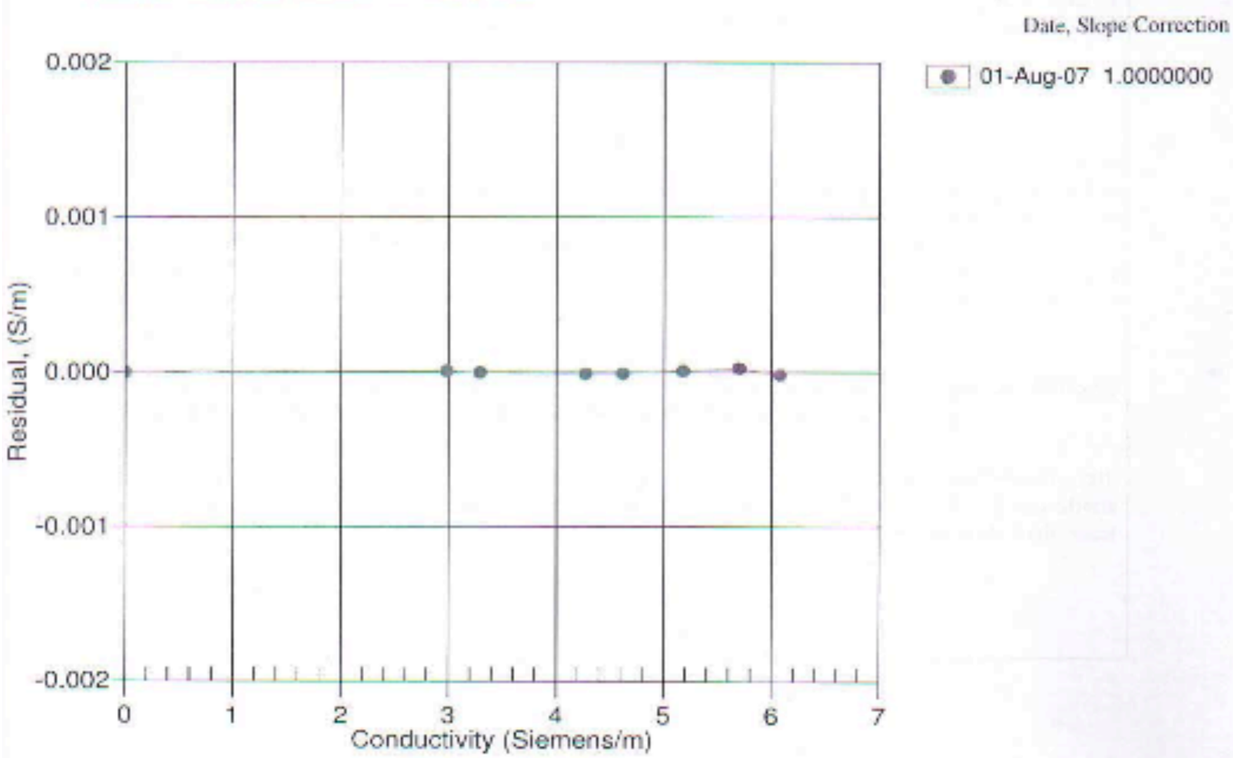
BATH TEMP (ITS-90)	BATH SAL (PSU)	BATH COND (Siemens/m)	INST FREQ (Hz)	INST COND (Siemens/m)	RESIDUAL (Siemens/m)
22.0000	0.0000	0.00000	2641.45	0.00000	0.00000
1.0000	34.8934	2.98192	5303.53	2.98193	0.00001
4.5000	34.8731	3.28955	5504.48	3.28955	-0.00000
15.0000	34.8297	4.27308	6101.73	4.27307	-0.00001
18.5001	34.8207	4.61890	6297.94	4.61889	-0.00001
24.0000	34.8111	5.17793	6602.44	5.17794	0.00001
29.0001	34.8062	5.70086	6874.67	5.70088	0.00002
32.4999	34.8046	6.07417	7062.34	6.07415	-0.00002

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



Remote Sea Temperature (Sea Chest)

Serial # 4063

SEA-BIRD ELECTRONICS, INC.

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

SENSOR SERIAL NUMBER: 4063
CALIBRATION DATE: 13-Dec-07

SBE3 TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

ITS-90 COEFFICIENTS
g = 4.29921671e-003
h = 6.36406488e-004
i = 2.06912541e-005
j = 1.52019386e-006
f0 = 1000.0

IPTS-68 COEFFICIENTS
a = 3.68121265e-003
b = 5.99688417e-004
c = 1.61521904e-005
d = 1.52164480e-006
f0 = 2721.791

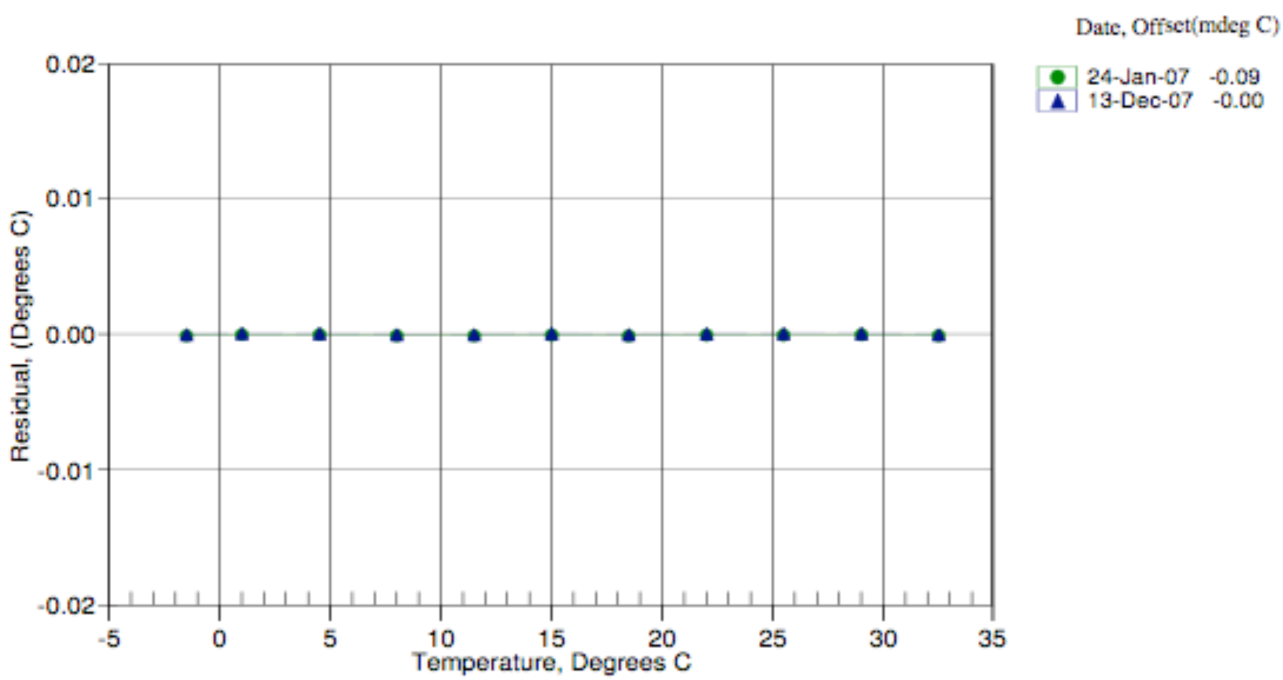
BATH TEMP (ITS-90)	INSTRUMENT FREQ (Hz)	INST TEMP (ITS-90)	RESIDUAL (ITS-90)
-1.5000	2721.791	-1.5000	-0.00002
1.0000	2878.781	1.0000	0.00003
4.5000	3109.455	4.5000	0.00002
8.0000	3353.176	8.0000	-0.00001
11.5000	3610.316	11.5000	-0.00001
15.0000	3881.236	15.0000	0.00002
18.5000	4166.278	18.5000	-0.00004
22.0000	4465.803	22.0000	0.00000
25.5000	4780.134	25.5000	0.00003
29.0000	5109.596	29.0000	0.00002
32.5000	5454.501	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



Oxygen Sensor A

Serial # 1307

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

SENSOR SERIAL NUMBER: 1307
CALIBRATION DATE: 28-Sep-07p

SBE 43 OXYGEN CALIBRATION DATA

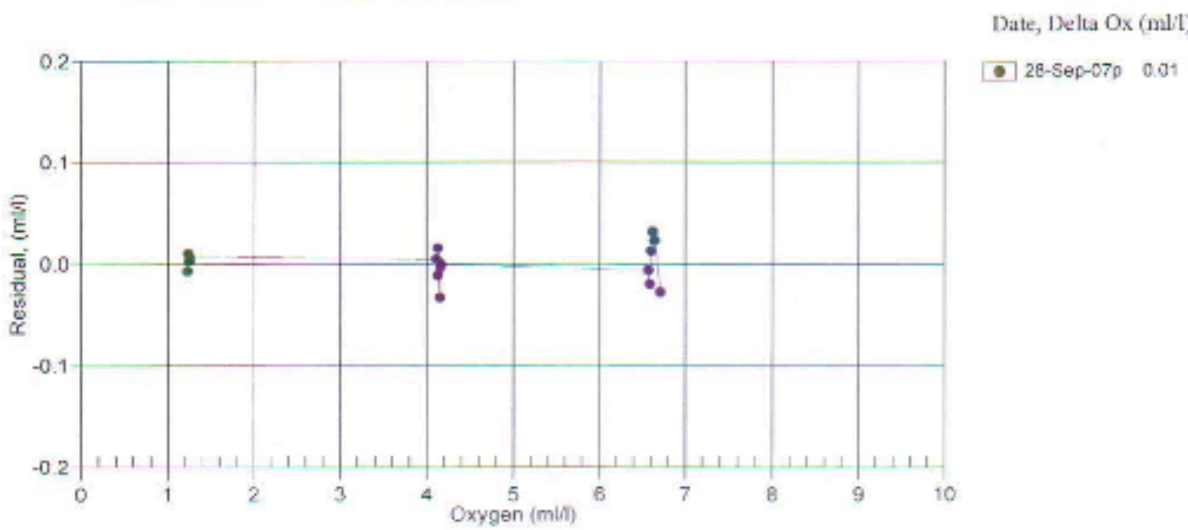
COEFFICIENTS

Soc = 0.3834
Boc = 0.0000
Voffset = -0.4781

TCor = 0.0025
PCor = 1.350e-04

BATH OX (ml/l)	BATH TEMP ITS-90	BATH SAL PSU	INSTRUMENT OUTPUT(VOLTS)	INSTRUMENT OXYGEN(ml/l)	RESIDUAL (ml/l)
1.22	2.00	0.00	0.805	1.22	-0.01
1.24	12.00	0.01	0.898	1.25	0.01
1.24	20.00	0.01	0.966	1.25	0.01
1.24	26.00	0.01	1.016	1.25	0.00
1.25	6.00	0.00	0.848	1.25	0.00
1.25	30.00	0.01	1.057	1.26	0.01
4.11	20.00	0.01	2.086	4.11	0.00
4.13	26.00	0.01	2.254	4.11	-0.01
4.13	12.00	0.01	1.870	4.14	0.02
4.15	2.00	0.00	1.583	4.11	-0.03
4.15	30.00	0.01	2.382	4.15	-0.00
4.15	6.00	0.00	1.705	4.15	-0.00
6.57	30.00	0.01	3.491	6.57	-0.01
6.58	26.00	0.01	3.311	6.56	-0.02
6.60	20.00	0.01	3.061	6.61	0.01
6.62	12.00	0.01	2.712	6.65	0.03
6.64	6.00	0.00	2.447	6.67	0.02
6.71	2.00	0.00	2.273	6.68	-0.03

oxygen (ml/l) = (Soc * (V + Voffset)) * exp(Tcor * T) * Oxsat(T,S) * exp(Pcor * P)
V = voltage output from SBE43, T = temperature [deg C], S = salinity [PSU]
Oxsat(T,S) = oxygen saturation [ml/l], P = pressure [dbar]
Residual = instrument oxygen - bath oxygen



CTD Sensors

Pressure Sensor

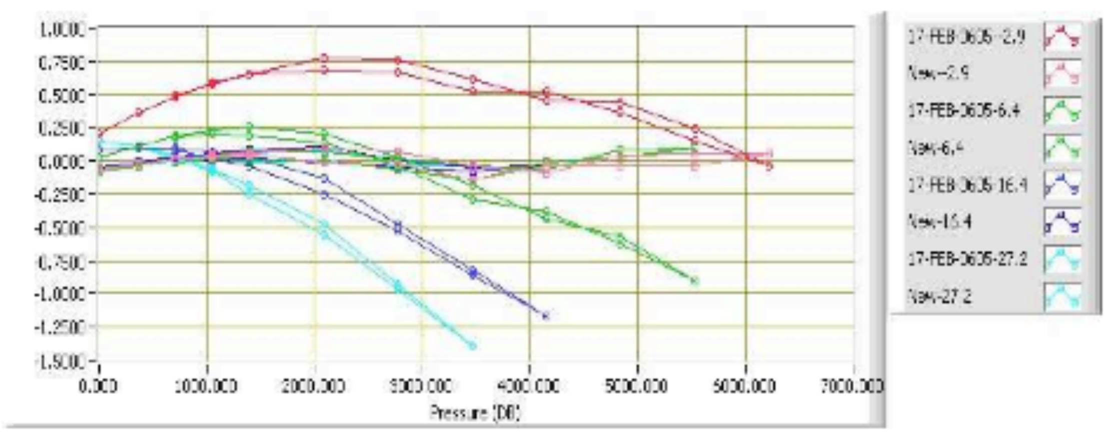
Serial # 83012

Pressure Calibration Report
STS/ODF Calibration Facility

SENSOR SERIAL NUMBER: 639
CALIBRATION DATE: 18-JAN-2008
Mfg: Seabird Model: SBE9P CTD Prs s/n: 83012

C1= -3.841449E+4
C2= 4.630485E-1
C3= 1.014581E-2
D1= 3.051116E-2
D2= 0.000000E+0
T1= 3.019016E+1
T2= -1.746821E-4
T3= 4.517296E-6
T4= -9.087207E-9
T5= 0.000000E+0
AD590M= 1.27551E-2
AD590B= -9.09133E+0
Slope = 1.0
Offset = 0.0

Calibration Standard: Mfg: Ruska Model: 2400 s/n: 34336
t0=t1+t2*td+t3*td*td+t4*td*td*td
w = 1-t0*t0*f*f
Pressure = (0.6894759*((c1+c2*td+c3*td*td)*w*(1-(d1+d2*td)*w)-14.7)



Temperature #1

Serial # 2855

Temperature Calibration Report
STS/ODF Calibration Facility

SENSOR SERIAL NUMBER: 2855
CALIBRATION DATE: 21-JAN-2008
Mfg: Seabird Model: SBE3Plus
Previous Cal Date: 24-Jan-07
Calibration Tech: CM

g= 4.35951439E-3
h= 6.45648951E-4
i= 2.38075037E-5
j= 2.35385504E-6
f0 = 1000.0
Slope = 1.0
Offset = 0.0

Calibration Standard: Mfg: ASL Model: F18 s/n: 245-5149
Temperature ITS-90 = 1/{g+h[ln(f0/f)]+i[ln2(f0/f)]+j[ln3(f0/f)]} - 273.15 (°C)

SBE3 Freq	SPRT	SBE3 New_Coefs	SPRT-SBE3 Prev_Coefs	SPRT-SBE3 New_Coefs
5479.6760	28.1875	28.1875	0.00140	0.00002
5798.0010	31.2142	31.2142	0.00189	-0.00002
5174.8630	25.1737	25.1737	0.00101	0.00002
4839.0220	21.7073	21.7073	0.00066	-0.00000
4563.9390	18.7410	18.7410	0.00045	-0.00003
4313.5900	15.9306	15.9306	0.00036	-0.00000
4062.6960	12.9964	12.9964	0.00029	0.00002
3819.2680	10.0242	10.0242	0.00019	-0.00001
3580.6660	6.9771	6.9771	0.00011	-0.00001
3359.2520	4.0167	4.0167	0.00007	0.00004
3216.0510	2.0264	2.0264	-0.00010	-0.00004
3143.3570	0.9916	0.9916	-0.00010	0.00002
3042.0950	-0.4792	-0.4792	-0.00018	0.00003
3003.6410	-1.0471	-1.0471	-0.00029	-0.00003
2934.0140	-2.0888	-2.0888	-0.00036	-0.00001

Temperature #2

Serial # 2796

Temperature Calibration Report
STS/ODF Calibration Facility

SENSOR SERIAL NUMBER: 2796
CALIBRATION DATE: 21-JAN-2008
Mfg: Seabird Model: SBE3Plus
Previous Cal Date: 27-Jan-07
Calibration Tech: CM

g= 4.30545772E-3
h= 6.41541965E-4
i= 2.26535491E-5
j= 2.15838215E-6
f0 = 1000.0
Slope = 1.0
Offset = 0.0

Calibration Standard: Mfg: ASL Model: F18 s/n: 245-5149
Temperature ITS-90 = 1/{g+h[ln(f0/f)]+i[ln2(f0/f)]+j[ln3(f0/f)]} - 273.15 (°C)

SBE3 Freq	SPRT	SBE3 New_Coefs	SPRT-SBE3 Prev_Coefs	SPRT-SBE3 New_Coefs
5034.9080	28.1869	28.1869	0.00129	-0.00001
5327.3120	31.2134	31.2134	0.00145	0.00001
4754.9570	25.1736	25.1736	0.00117	-0.00003
4446.4900	21.7075	21.7075	0.00113	0.00003
4193.8400	18.7414	18.7414	0.00105	0.00000
3963.9100	15.9311	15.9311	0.00097	-0.00004
3733.4680	12.9969	12.9969	0.00098	0.00001
3509.8970	10.0249	10.0248	0.00098	0.00005
3290.7460	6.9777	6.9777	0.00087	-0.00002
3087.3980	4.0175	4.0175	0.00082	-0.00001
2955.8690	2.0273	2.0273	0.00077	-0.00001
2889.1220	0.9928	0.9928	0.00074	-0.00001
2796.0920	-0.4783	-0.4783	0.00068	-0.00002
2760.7580	-1.0463	-1.0463	0.00070	0.00001
2696.7970	-2.0881	-2.0881	0.00067	0.00003

Temperature #3

Serial # 0011

SBE35 V 2.0a   SERIAL NO. 0011   25 Jun 2008
number of measurement cycles to average = 8
number of data points stored in memory = 0
bottle confirm interface = SBE 911plus

SBE35 V 2.0a   SERIAL NO. 0011
29-mar-08
A0 = 5.030840630e-03
A1 = -1.387153030e-03
A2 = 2.040326840e-04
A3 = -1.129031550e-05
A4 = 2.392311380e-07
SLOPE = 1.000000
OFFSET = 0.000000

Conductivity #1

Serial # 2568

SEA-BIRD ELECTRONICS, INC.

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

SENSOR SERIAL NUMBER: 2568
CALIBRATION DATE: 18-Jan-08

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

GHIJ COEFFICIENTS
g = -1.03670721e+001
h = 1.48463602e+000
i = 3.18405740e-004
j = 6.15207682e-005
CPcor = -9.5700e-008 (nominal)
CTcor = 3.2500e-006 (nominal)

ABCDM COEFFICIENTS
a = [illegible]
b = 1.48492009e+000
c = -1.03867251e+001
d = 8.28372679e-005
m = 3.5
CPcor = -9.5700e-008 (nominal)

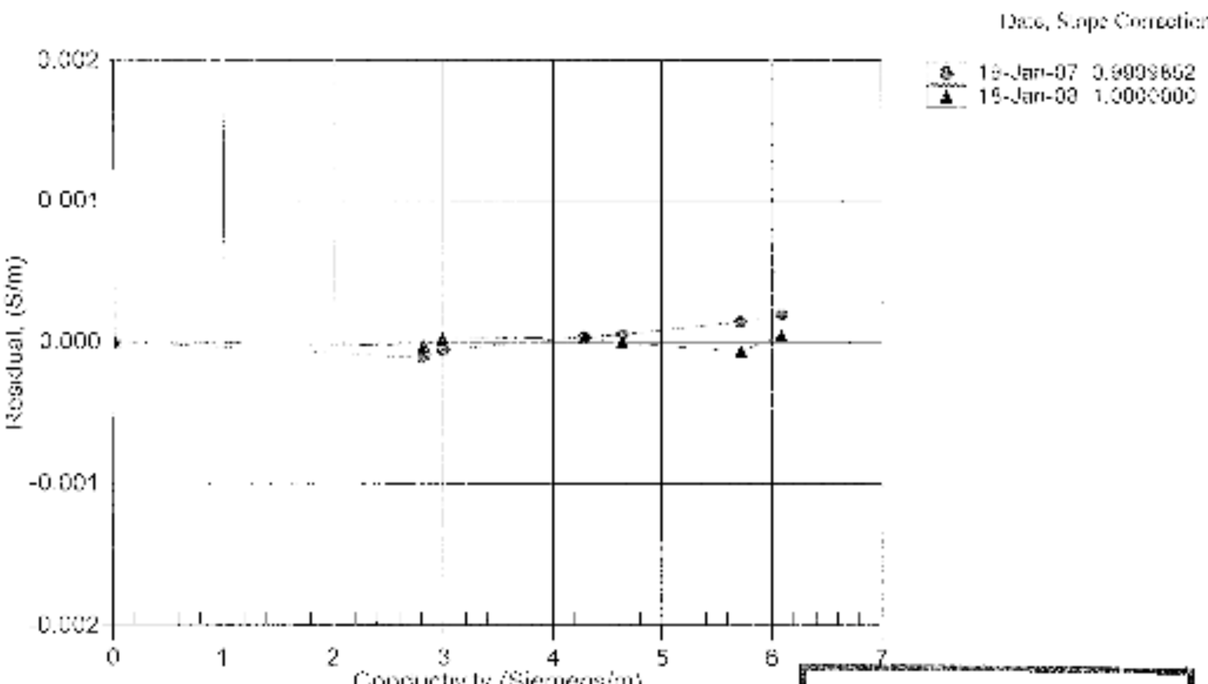
BATH TEMP (ITS-90)	BATH SAL (PSU)	BATH COND (Siemens/m)	INST FREQ (kHz)	INST COND (Siemens/m)	RESIDUAL (Siemens/m)
0.0000	0.0000	0.00000	2.64369	0.00000	0.00000
-1.0000	34.9227	2.81315	5.08747	2.81312	-0.00003
1.0000	34.9240	2.98906	5.19962	2.98908	0.00002
15.0000	34.9342	4.28454	5.97907	4.28458	0.00004
18.5000	34.9039	4.63019	6.17084	4.63014	-0.00005
29.0000	34.9293	5.71874	6.72469	5.71867	-0.00007
32.5000	34.9158	6.09195	6.90477	6.09201	0.00005

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

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

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

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



POST CRUISE CALIBRATION

Conductivity # 2

Serial # 2561

SEA-BIRD ELECTRONICS, INC.

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

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

SENSOR SERIAL NUMBER: 2561
CALIBRATION DATE: 18-Jan-08

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

GHIJ COEFFICIENTS

g = -1.0[illegible]e+001
h = 1.0[illegible]e+000
i = -1.0[illegible]e-003
j = [illegible]e-004
CPcor = -9.[illegible]e-008 (nominal)
CTcor = [illegible]e-006 (nominal)

ABCDM COEFFICIENTS

a = [illegible]e-005
b = 1.[illegible]e+000
c = -1.[illegible]e+001
d = -[illegible]e-005
m = [illegible]
CPcor = -[illegible]e-008 (nominal)

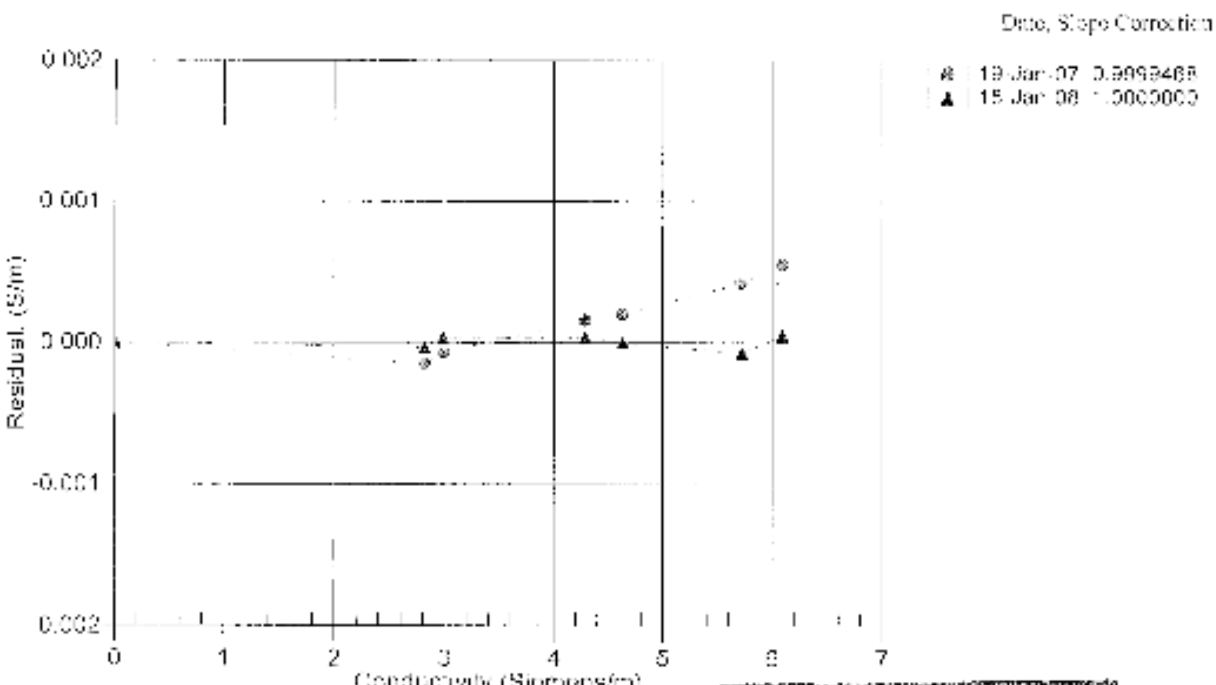
BATH TEMP (ITS-90)	BATH SAL (PSU)	BATH COND (Siemens/m)	INST FREQ (kHz)	INST COND (Siemens/m)	RESIDUAL (Siemens/m)
0.0000	0.0000	0.00000	[illegible]	0.00000	0.00000
-1.0000	34.9[illegible]	2.81[illegible]	[illegible]	[illegible]	-0.0000[illegible]
1.0000	[illegible]	2.98596	[illegible]	2.98[illegible]	0.0000[illegible]
15.0000	34.9[illegible]	4.28454	5.71[illegible]	4.28458	[illegible]
18.5000	34.9330	4.63228	[illegible]	4.63228	-0.00000
29.0000	34.9295	5.71[illegible]	[illegible]	5.71[illegible]	0.0000[illegible]
32.5000	34.9195	6.09[illegible]	6.81[illegible]	6.09[illegible]	[illegible]

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



POST CRUISE CALIBRATION

Oxygen

Serial # 0458

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

SENSOR SERIAL NUMBER: 0458
CALIBRATION DATE: 12-Dec-07p

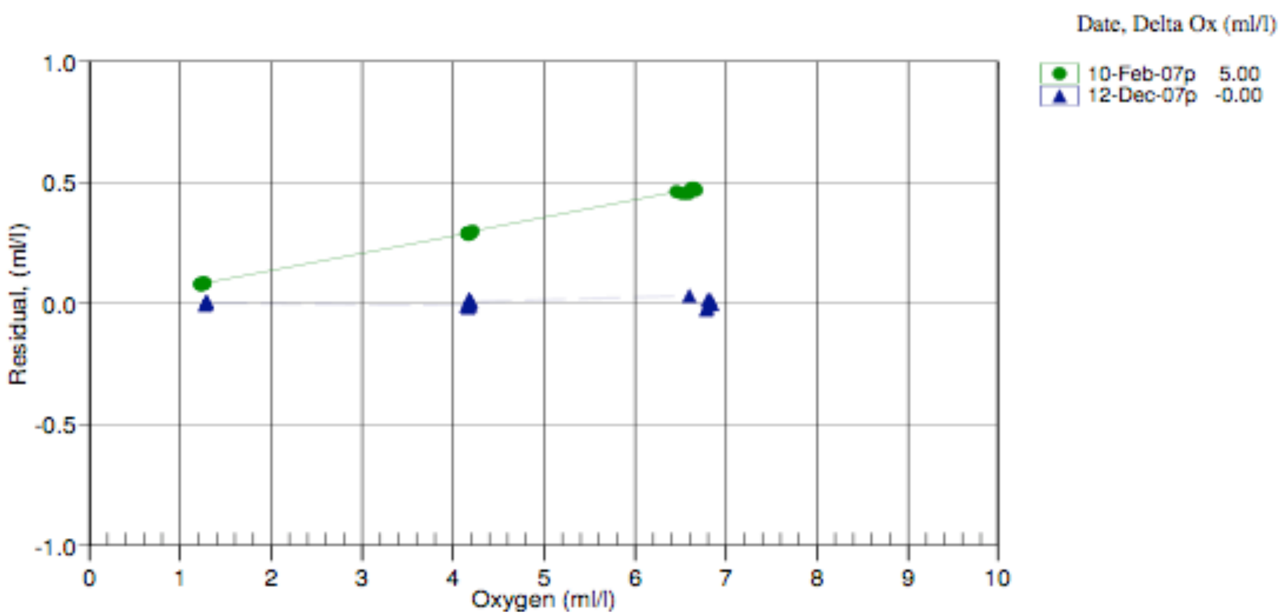
SBE 43 OXYGEN CALIBRATION DATA

COEFFICIENTS
Soc = 0.4060
Boc = 0.0000
Voffset = -0.4927

TCor = 0.0006
PCor = 1.350e-04

BATH OX (ml/l)	BATH TEMP ITS-90	BATH SAL PSU	INSTRUMENT OUTPUT(VOLTS)	INSTRUMENT OXYGEN(ml/l)	RESIDUAL (ml/l)
1.27	20.00	0.01	0.979	1.27	-0.01
1.28	26.00	0.01	1.037	1.27	-0.01
1.28	12.00	0.01	0.909	1.28	0.00
1.28	2.00	0.00	0.820	1.28	0.00
1.29	6.00	0.00	0.858	1.29	0.01
1.29	30.00	0.01	1.085	1.29	0.00
4.15	26.00	0.01	2.265	4.13	-0.01
4.16	20.00	0.01	2.083	4.15	-0.02
4.17	12.00	0.01	1.847	4.17	0.00
4.18	30.00	0.01	2.419	4.19	0.02
4.19	2.00	0.00	1.556	4.18	-0.01
4.19	6.00	0.00	1.677	4.20	0.01
6.59	30.00	0.01	3.535	6.62	0.03
6.78	20.00	0.01	3.082	6.75	-0.03
6.79	26.00	0.01	3.397	6.77	-0.02
6.80	12.00	0.01	2.706	6.81	0.01
6.82	6.00	0.00	2.420	6.83	0.01
6.84	2.00	0.00	2.234	6.84	-0.00

oxygen (ml/l) = (Soc * (V + Voffset)) * exp(Tcor * T) * Oxsat(T,S) * exp(Pcor * P)
V = voltage output from SBE43, T = temperature [deg C], S = salinity [PSU]
Oxsat(T,S) = oxygen saturation [ml/l], P = pressure [dbar], Residual = instrument oxygen - bath oxygen



Fluorometer

Serial # 088234

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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Tel: +44 (0)20 8481 9000
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sales@chelsea.co.uk
www.chelsea.co.uk

Date of issue	06 March 2007
Description	Mk III Aquatracka (Chlorophyll-a)
Serial Number	088234
Part No	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.

$$\text{Conc.} = (0.00779 \times 10^{\text{Output}}) - 0.0211$$

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 0.02 microgrammes per litre plus 5% 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

Transmisometer

Serial # CST-390DR

PO Box 518
620 Applegate St.
Philomath, OR 97370

WET Labs

(541) 929-565
Fax (541) 929-527
www.wetlabs.co

C-Star Calibration

Date February 27, 2007 Customer US Coast Guard Work order 004

Job # 0012004 S/N# CST-390DR Pathlength 25 cm

	Analog meter
V_d	0.058 V
V_{air}	4.788 V
V_{ref}	4.707 V

Temperature of calibration water	18.8 °C
Ambient temperature during calibration	23.4 °C

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

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

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

V_d Meter output with the beam blocked. This is the offset.
V_{air} Meter output in air with a clear beam path.
V_{ref} Meter output with clean water in the path.
Temperature of calibration water: temperature of clean water used to obtain V_{ref}.
Ambient temperature: meter temperature in air during the calibration.
V_{sig} Measured signal output of meter.

cstarwkbkf1.xls Revision F 1/17/05

PAR

Serial # 70115

Calibration Date:	01/09/07			**Job No.:**	L9511
Model Number:	QSP2300				
Serial Number:	70115				
Operator:	TPC				
Standard Lamp:	F-863(9/30/05)				
Operating Voltage Range:	6	to	15	VDC (+)	

Note: The QSP-2300 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:	**3.22E+12**	**quanta/cm²·sec per volt**	**5.34E-06**	**µEinsteins/cm²·sec per volt**
Wet Calibration Factor:	**5.42E+12**	**quanta/cm²·sec per volt**	**9.00E-06**	**µEinsteins/cm²·sec per volt**

Sensor Test Data and Results[2)]

Sensor Supply Current (Dark):	3.5	mA		
Supply Voltage:	6	Volts		
Lamp Integrated PAR Irradiance:	9.43E+15	quanta/cm^2·sec	0.01566	µEinsteins/cm²sec
SC3 Immersion Coefficient:	0.594			

Nominal Filter OD	Expected Transmission	Calibrated Trans.	Sensor Voltage	Expected Voltage	Voltage % Error	Measured Trans.	Transmission Error (%)	Test Irrad. (quanta/ cm^2·sec)
No Filter	100%	100.00%	3.467	3.467	0%	100.00%	0.0	9.43E+15
0.3	50%	36.10%	3.007	3.024	-1%	34.66%	4.2	3.27E+15
0.5	32%	27.60%	2.897	2.908	0%	26.87%	2.7	2.54E+15
1	10%	9.27%	2.478	2.434	2%	10.22%	-9.3	9.66E+14
2	1%	1.11%	1.608	1.512	6%	1.35%	-17.7	1.30E+14
3	0.10%	0.05%	0.500	0.194	61%	0.07%	-27.4	1.02E+13

Dark Before:	0.003	Volts
Light - No Filter Hldr.:	3.467	Volts
Dark After - NFH:	0.003	Volts
Average Dark	0.00274	Volts

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

Gravity Meters

Serial # 221

BGM-3 PLATFORM TESTS

Sensor Subsys. S/N 221
C.P.S. S/N 324
Platform S/N 324

ZERO DAMP period (SPEC: 533 SEC +/- 5)

		ROLL (R49)	PITCH (R65)	
11 FEB 08	2157Z	531 sec.	530 sec.	2208Z
		sec.	sec.	
		sec.	sec.	

TILT TEST (SPEC: +/- 0.7 MRAD)

			ROLL (R41)		PITCH (R56)	
2343Z	NOMINAL		979 318.03			
	POS		316.95 mgal.		317.16 mgal.	12 FEB 08 0001
	NEG		317.00 mgal.		316.62 mgal.	
	.36 (POS - NEG)	-.05	-0.018 **mrad**	.54	0.194 **mrad**	
	Adjustments		NONE		NONE	
12 FEB 08 0114	NOMINAL		979 317.94			
	POS		mgal.		mgal.	
	NEG		mgal.		mgal.	
	.36 (POS - NEG)		**mrad**		**mrad**	
	Adjustments					
	NOMINAL					
	POS		mgal.		mgal.	
	NEG		mgal.		mgal.	
	.36 (POS - NEG)		**mrad**		**mrad**	
	Adjustments					
	NOMINAL					
	POS		mgal.		mgal.	
	NEG		mgal.		mgal.	
	.36 (POS - NEG)		**mrad**		**mrad**	
	Adjustments					
	NOMINAL					
	POS		mgal.		mgal.	
	NEG		mgal.		mgal.	
	.36 (POS - NEG)		**mrad**		**mrad**	
	Adjustments					
	NOMINAL					

PRE-SHIPMENT SYSTEM CHECKOUT

SENSOR S/N 221 — DATE 12 FEB 08
CPS S/N 324 — TIME (Z) 0020
PLATFORM S/N 324
SCALE FACTOR 5.0173887349
BIAS 855285.8361

SENSOR TEST POINTS		CPS MONITOR	
1	30.08	1	14.80
2	27.98	2	10.02
3	18.50	3	1.006
4	17.62	4	0.00
5	15.09	5	0.00
6	−15.00	6	−0.02
7	—	7	0.727
8	5.02	8	−0.045
9	13.67	9	0.025
10	17.68		
11	6.50		
12	−0.07		
13	5.0 — 0		
14	−17.95		
15	−6.92		
16	0.00		

ACCEL OVEN 80
PRC OVEN 50
BPTC OVEN .65
BAT VOLTAGE 28.0
ELEX VOLTAGE 29.4
ELEC CURRENT .16A
CHGR CURRENT .03A

AARV SYSTEM

POST INSTALLATION SYSTEM CHECKOUT					
SENSOR S/N	221	DATE 28 FEB 08			
CPS S/N	324	TIME (Z) 1700			
PLATFORM S/N	324				
SCALE FACTOR	5.017387349				
BIAS	855285.84				
SENSOR TEST POINTS		CPS MONITOR			
1	29.95	1	14.82		
2	27.87	2	10.04		
3	18.41	3	1.005		
4	17.55	4	0.00		
5	15.03	5	0.00		
6	-14.93	6	1.22		
7	—	7	-.076		
8	5.00	8	-.053		
9	13.60	9	.024		
10	17.60				
11	6.47				
12	.005				
13	0/L				
14	-17.87				
15	-6.90				
16	0.000				
ACCEL OVEN	75				
PRC OVEN	44				
BPTC OVEN	.64				
BAT VOLTAGE	28.5				
ELEX VOLTAGE	29.5				
ELEC CURRENT	.16				
CHGR CURRENT	.02				

Post-installation.

AARV SYSTEM

BGM-3 PLATFORM TESTS

28FEB08

Sensor Subsys.	**S/N** 221	
C.P.S.	**S/N** 324	
Platform	**S/N** 324	

180 SECOND FILTER

ZERO DAMP period (SPEC: 533 SEC +/- 5)

	ROLL (R49)	**PITCH (R65)**	
1720Z	530 sec. OK	(526) sec.	1732Z
	sec.	sec.	R65 4 ccw
	sec.	534 sec.	1833Z OK

TILT TEST (SPEC: +/- 0.7 MRAD)

		ROLL (R41)		**PITCH (R56)**	
	NOMINAL	979 730.50			
1800Z	POS	29.85 mgal.		29.55 mgal.	1815Z
	NEG	29.21 mgal.	OK	29.59 mgal.	OK
	.36 (POS - NEG) .64	0.230 **mrad**	-.04	-.014 **mrad**	
	Adjustments	NONE		NONE	
1846Z	NOMINAL	979730.50			
	POS	mgal.		mgal.	
	NEG	mgal.		mgal.	
	.36 (POS - NEG)	**mrad**		**mrad**	
	Adjustments				
	NOMINAL				
	POS	mgal.		mgal.	
	NEG	mgal.		mgal.	
	.36 (POS - NEG)	**mrad**		**mrad**	
	Adjustments				
	NOMINAL				
	POS	mgal.		mgal.	
	NEG	mgal.		mgal.	
	.36 (POS - NEG)	**mrad**		**mrad**	
	Adjustments				
	NOMINAL				
	POS	mgal.		mgal.	
	NEG	mgal.		mgal.	
	.36 (POS - NEG)	**mrad**		**mrad**	
	Adjustments				
	NOMINAL				

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:

Serial # 222

BGM-3 PLATFORM TESTS

Sensor Subsys.	**S/N** 222
C.P.S.	**S/N** 325
Platform	**S/N** 325

ZERO DAMP period (SPEC: 533 SEC +/- 5)

11 FEB 08

	ROLL (R49)	PITCH (R65)	
2222 Z	533 sec.	534 sec.	2236Z
	____ sec.	____ sec.	
	____ sec.	____ sec.	

TILT TEST (SPEC: +/- 0.7 MRAD)

		ROLL (R41)	PITCH (R56)	
2343Z	NOMINAL	979315.24		12Feb08
	POS	312.18 mgal.	312.06 mgal.	0001
	NEG	312.21 mgal.	312.30 mgal.	
	.36 (POS - NEG) -0.03	-0.0108 mrad	-.24 -0.0864 mrad	
	Adjustments	None	None	
12Feb08 0014	NOMINAL	979313.31		
	POS	____ mgal.	____ mgal.	
	NEG	____ mgal.	____ mgal.	
	.36 (POS - NEG)	____ mrad	____ mrad	
	Adjustments	____	____	
	NOMINAL	____		
	POS	____ mgal.	____ mgal.	
	NEG	____ mgal.	____ mgal.	
	.36 (POS - NEG)	____ mrad	____ mrad	
	Adjustments	____	____	
	NOMINAL	____		
	POS	____ mgal.	____ mgal.	
	NEG	____ mgal.	____ mgal.	
	.36 (POS - NEG)	____ mrad	____ mrad	
	Adjustments	____	____	
	NOMINAL	____		
	POS	____ mgal.	____ mgal.	
	NEG	____ mgal.	____ mgal.	
	.36 (POS - NEG)	____ mrad	____ mrad	
	Adjustments	____	____	
	NOMINAL	____		

PRE-SHIPMENT SYSTEM CHECKOUT

SENSOR S/N	222	DATE	12FEB08
CPS S/N	325	TIME (Z)	0015
PLATFORM S/N	325		
SCALE FACTOR	4.949006443		
BIAS	856735.6953		

SENSOR TEST POINTS		CPS MONITOR	
1	30.23	1	14.50
2	28.06	2	9.90
3	18.54	3	0.985
4	17.74	4	0.05
5	15.04	5	0.05
6	-14.98	6	-0.691
7	—	7	1.013
8	5.04	8	-0.071
9	13.86	9	-0.012
10	18.03		
11	6.52		
12	-.04		
13	5.0 – 0		
14	-18.23		
15	-6.94		
16	.02		

ACCEL OVEN	100
PRC OVEN	45
BPTC OVEN	.65
BAT VOLTAGE	26.5
ELEX VOLTAGE	27.8
ELEC CURRENT	.15 A
CHGR CURRENT	.02 A

HEALY SYSTEM

POST INSTALLATION SYSTEM CHECKOUT

SENSOR S/N	222	DATE	28 FEB 08
CPS S/N	325	TIME (Z)	1710
PLATFORM S/N	325		
SCALE FACTOR	4.949006443		
BIAS	~~855285.84~~ 856735.70		

SENSOR TEST POINTS		CPS MONITOR	
1	30.01	1	14.47
2	27.95	2	9.92
3	18.45	3	.985
4	17.66	4	.04
5	14.95	5	.05
6	-14.95	6	.373
7	—	7	.281
8	4.99	8	-.073
9	13.77	9	-.010
10	17.93		
11	6.47		
12	.016		
13	O/C		
14	-18.18		
15	-6.94		
16	0.000		

ACCEL OVEN	95
PRC OVEN	45
BPTC OVEN	.65
BAT VOLTAGE	26.9
ELEX VOLTAGE	28.0
ELEC CURRENT	.17
CHGR CURRENT	.02

POST- INSTALLATION

HEALY SYSTEM

BGM-3 PLATFORM TESTS

28 FEB 08

Sensor Subsys.	**S/N** 222
C.P.S.	**S/N** 325
Platform	**S/N** 325

ZERO DAMP period (SPEC: 533 SEC +/- 5)

	ROLL (R49)	**PITCH (R65)** OK
1930Z	532 sec. OK	535 sec. 1945Z
	____ sec.	____ sec.
	____ sec.	____ sec.

TILT TEST (SPEC: +/- 0.7 MRAD)

	ROLL (R41)	**PITCH (R56)**
1843Z NOMINAL	979 724.92	
POS	23.82 mgal.	24.03 mgal. 1859Z
NEG	24.16 mgal.	23.92 mgal.
.36 (POS - NEG) -.32	-.115 **mrad** .11	.039 **mrad**
Adjustments	NONE OK	NONE OK
NOMINAL		
POS	____ mgal.	____ mgal.
NEG	____ mgal.	____ mgal.
.36 (POS - NEG)	____ **mrad**	____ **mrad**
Adjustments	____	____
NOMINAL		
POS	____ mgal.	____ mgal.
NEG	____ mgal.	____ mgal.
.36 (POS - NEG)	____ **mrad**	____ **mrad**
Adjustments	____	____
NOMINAL		
POS	____ mgal.	____ mgal.
NEG	____ mgal.	____ mgal.
.36 (POS - NEG)	____ **mrad**	____ **mrad**
Adjustments	____	____
NOMINAL		
POS	____ mgal.	____ mgal.
NEG	____ mgal.	____ mgal.
.36 (POS - NEG)	____ **mrad**	____ **mrad**
Adjustments	____	____
NOMINAL		

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: ______

Instrument Locations on the Healy

Layout plot of instrument locations

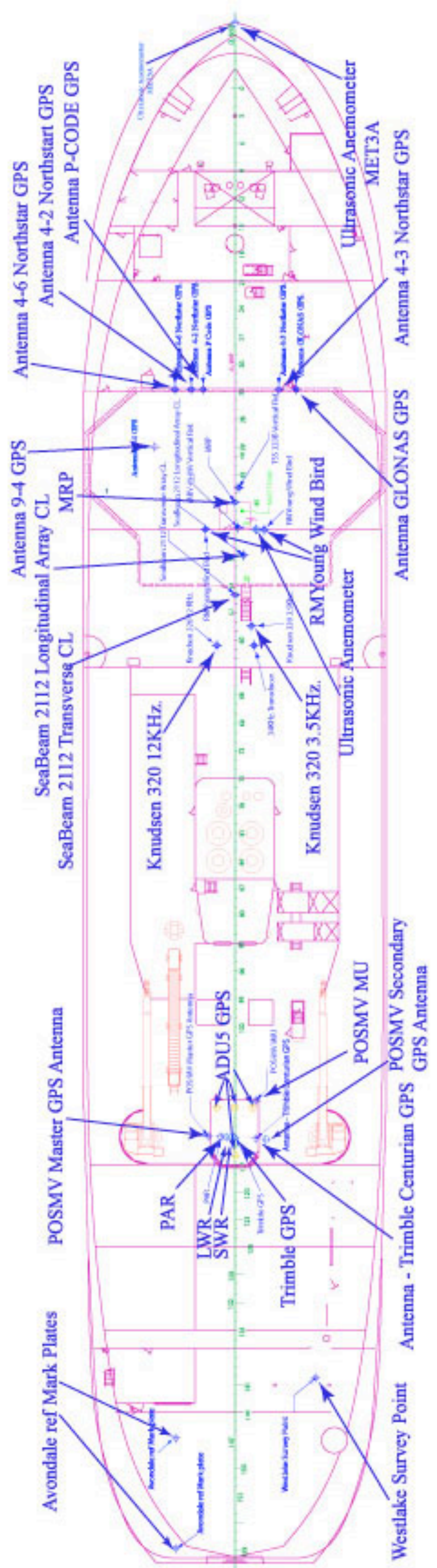

Table of Survey measurements

Consolidated Survey Data						
	Elements of:					
		Avondale Survey				
		Westlake Survey				
		Lamont Survey				
	All Measurements in *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	**Seabeam 2112**				
		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
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			

			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

SBE 21 SEACAT Thermosalinograph Data Output Formats

This is extracted from page 33 of the SBE 21 SEACAT Thermosalinograph User's Manual (SeaBird Manual Version #022, 03/30/07).

The SBE 21 outputs data in raw, hexadecimal form as described below.

The inclusion of some output parameters is dependent on the system configuration - if the specified sensor is not enabled (see *Command Descriptions* above), the corresponding data is not included in the output data stream, shortening the data string.

• SBE 21 Format (**F1**) - ttttccccrrrrrruuuvvvwwwxxx (use this format if you will be using SEASAVE to acquire real-time data and/or SBE Data Processing to process the data)

• SBE 16 Format (**F2**) - #ttttccccrrrrrruuuvvvwwwxxxnnnn (custom format)

where

tttt = primary temperature

cccc = conductivity

rrrrrr = remote temperature (from SBE 38 or SBE 3 remote sensor)

uuu, vvv, www, xxx = voltage outputs 0, 1, 2, and 3 respectively

= attention character

nnnn = lineal sample count (0, 1, 2, etc.)

Data is output in the order listed, with no spaces or commas between parameters. Shown with each parameter is the number of digits.

Calculation of the parameter from the data is described below (use the decimal equivalent of the hex data in the equations).

1. Temperature

   temperature frequency (Hz) = (tttt / 19) + 2100

2. Conductivity

   conductivity frequency (Hz) = square root [(cccc * 2100) + 6250000]

3. SBE 3 secondary temperature (if **SBE3=Y**)

   SBE 3 temperature frequency (Hz) = rrrrrr / 256

4. SBE 38 secondary temperature (if **SBE38=Y**)

   SBE 38 temperature *psuedo* frequency (Hz) = rrrrrr / 256

5. External voltage 0 (if 1 or more external voltages defined with **SVx**)

   external voltage 0 (volts) = uuu / 819

6. External voltage 1 (if 2 or more external voltages defined with **SVx**)

   external voltage 1 (volts) = vvv / 819

7. External voltage 2 (if 3 or more external voltages defined with **SVx**)

   external voltage 2 (volts) = www / 819

8. External voltage 3 (if 4 external voltages defined with **SVx**)

   external voltage 3 (volts) = xxx / 819

Example: SBE 21 with SBE 38 and two external voltages sampled,

example scan = ttttccccrrrrrruuuvvv = A80603DA1B58001F5A21

• Temperature = tttt = A806 (43014 decimal);

temperature frequency = (43014 / 19) + 2100 = 4363.89 Hz

• Conductivity = cccc = 03DA (986 decimal);

conductivity frequency =

square root [986 *2100) + 6250000] = 2884.545 Hz

• SBE 38 = rrrrrr = 1B5800 (1,792,000 decimal)

temperature *pseudo* frequency (Hz) = (1,792,000 / 256) = 7000 Hz

• First external voltage = uuu = 1F5 (501 decimal);

voltage = 501 / 819 = 0.612 volts

• Second external voltage = vvv = A21 (2593 decimal);

voltage = 2593 / 819 = 3.166 volts

Note:

SBE 21 always outputs an even number of voltage characters. If you enable 1 or 3 voltages, it adds a *0* to the data stream before the last voltage, as shown below:

• Remote temperature and 1 voltage enabled –

ttttccccrrrrrr0uuu or

#ttttccccrrrrrr0uuunnnn

• Remote temperature and 3 voltages enabled –

ttttccccrrrrrruuuvvv0www

#ttttccccrrrrrruuuvvv0wwwnnnn

Notes:

• Sea-Bird's software (SEASAVE and SBE Data Processing) uses the equations shown to perform these calculations; it then uses the calibration coefficients in the configuration (.con) file to convert the raw frequencies and voltages to engineering units. Alternatively, you can use the equations to develop your own processing software.

• See *Notes on SBE 38 Remote Temperature Data Output Format* below for details on how Sea-Bird handles SBE 38 data.