NOAA *Okeanos Explorer* Program

FIELD SEASON 2011

EX GUIDE TO SCS DATA SENSORS AND FORMATS

By

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Purpose

The purpose of this document is to describe NOAA Ship *Okeanos Explorer* Scientific Computer System (SCS) as is set up for the 2011 Field Season. The intent of this report is to provide a comprehensive listing of all system components, configuration, calibrations and data formats. This document will be updated yearly, so please use the corresponding reference when working with the data, as configurations and calibrations may change from one field season to the next.

Background

NOAA Ship *Okeanos Explorer*, R 337 (WTDH) is NOAA's only ship dedicated exclusively for ocean exploration. *Okeanos Explorer* is one of the five former U.S. Navy T-AGOS ships acquired and converted by NOAA for use as scientific research ships. Originally built for anti-submarine warfare, former USNS Capable was commissioned as NOAA Ship *Okeanos Explorer* on August 13, 2008. Prior to commissioning, the vessel underwent extensive refurbishment from 2005 – 2008 by Todd Pacific Shipyards Corporation, including adding mission space for the ROV hanger, bow and stern thrusters, fairings for mapping sensors, and bridge upgradation. The ship has been outfitted with a deep-water multibeam echo sounder (MBES), a singlebeam echo sounder (SBES), and a subbottom profiler (SBP), along with host of ancillary equipment. Detailed layouts of the all of the new, modified and relocated equipment can be accessed at http://www.moc.noaa.gov/oe/index.html. Videos of the conversion can be accessed at http://oceanexplorer.noaa.gov/okeanos/welcome.html.

Vessel Specifications

Table 1. Vessel specifications available online at http://www.moc.noaa.gov/oe/Specs/General%20Specifications.pdf

Vessel Specifications			
Hull Number	337	Cruising speed	10 knots
Call letters	WTDH	Mapping speed	8 knots
Builder	VT Halter Marine, Inc., Moss Point, MS	Berthing	46
Launched	Oct 28, 1988	Commissioned officers	6
Delivered to NOAA	Sept 10, 2004	Licensed engineers	3
Commissioned	Aug 14, 2008	Crew	18
Length (LOA)	68.3 m (224 feet)	Scientists	19
Breadth	13.1 m (43 feet)	Ambar RHIB	2
Draft	5.18 m (17 feet)	Full Load displacement	2312 long tons
Range	9600 nm	Light ship displacement	1616 long tons
Endurance	40 days		

Main propulsion	2800 hp General electric DC drive motors	Power	4 Caterpillar D398 12 cylinder 800 HP diesel generators produce 240,000 watts at 600 vac.

Introduction to SCS

The Scientific Computer System (SCS) software was developed at NOAA Headquarters specifically for the NOAA fleet. SCS is a data acquisition system designed for oceanographic and fisheries applications. The C^{++} based software package is run through point and click menu bars. The SCS package utilizes Graphical User Interface (GUI) technology in the form of time series graphs and directly calls ArcView graphing capabilities.

SCS is capable of sending data displays to remote stations (SCS Client) throughout the labs. In addition, ASCII data strings can be sent via RS-232 cable or over the Ethernet. The SCS workstations can provide time series graphs of all acquired data to monitor any changes. Several variables can be plotted against each other in real time X-Y plots. Data can be output in a wide variety of formats. Data output formats include:

- raw data files in binary form
- ASCII data for easy transfer to PC environment

The Okeanos Explorer is currently operating with the first full database logging version of SCS, v4.3.4. The database is supported by Microsoft SQL Server. The theory is to be able to provide data to a wider range of professionals who can select specific data sets for specific time periods. This system is still under construction and testing.

SCS data is generally only collected while the ship is underway. Some of the sensors that are connected to SCS may be connected to other systems. As the ship progresses in its missions, there may be additional sensors added or subtracted to the ship's suite, models changed or the organization of the data modified. Please use this document on a cruise-by-cruise basis. As these changes are made they will be incorporated into the data archive.

SCS Acquisition is generally started before the ship leaves the dock, or as it is getting underway, and shut down after the ship reaches the pier, or very close to the pier. This may vary depending on time constraints for delivering the data package. (If person carrying the data has to get off the ship quickly, the data will be stopped sooner, otherwise it is on until the ship reaches the dock).

However, sometimes during a cruise, Acquisition has to be stopped to troubleshoot or modify a sensor. This will break up some of the data, in particular, the events. Some cruises may have more files than others due to stopping and restarting SCS. This is avoided as much as possible because so many things need to be restarted each time.

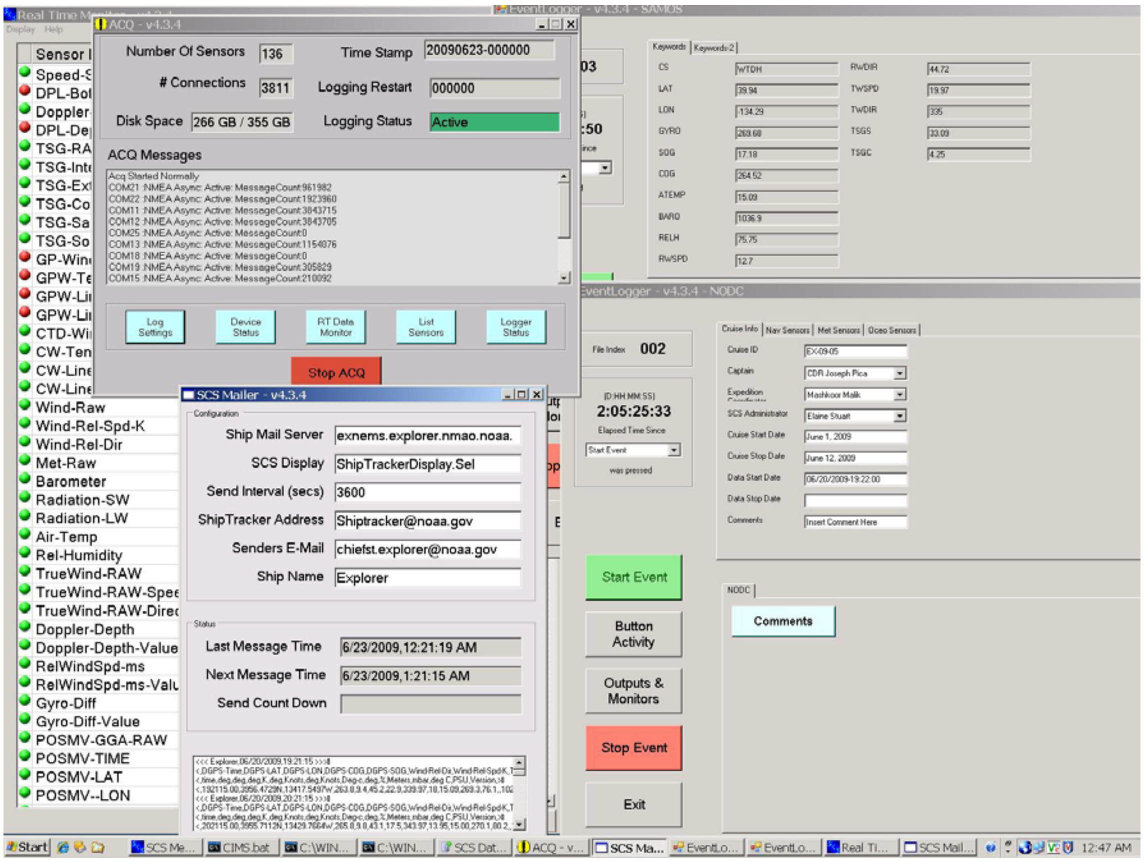


Figure 1: Screen grab of SCS Acquisition machine with events, mail messages, logging and real-time monitor windows. There are a lot of things going on at one time on the Acq machine, so the survey department is the only group to work with this machine during a cruise. Scientists can use client machines to build plots and view the real-time data.

Client machines are available for the scientific parties to use during a cruise. Since the survey department and electronic technicians are the only personnel trained in operating SCS, they are the only ones designated to do so. Otherwise, having visitors using the acquisition machine could result in data loss. Instead, the scientists can use designated work stations in the lab spaces to view the data and run events as necessary. The EX has a dedicated screen in the control room above the multibeam work station to view the meteorological and oceanographic data for recording hourly weather while surveying.

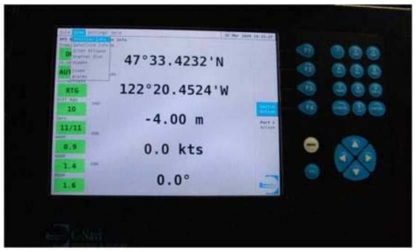
Sensors

The following describes the various groups of sensors currently on board the Okeanos Explorer and their configurations both as systems and as individual sensors. This includes layout, location, descriptions and data output.

Navigation:

The SCS navigation sensors are separate from the ship's navigation equipment on the bridge. They are only for scientific purposes.

Figure 2: Mapping Antenna Layout as of 2008. No adjustments have been made since 2008.



CNAV: A dynamic Digital Global Navigation Satellite System (DGNSS) precise point positioning system[1] by C & C Technologies.

The CNAV is our primary scientific navigation positioning system, with capabilities of a decimeter or better[1]. We have experienced holes in coverage in certain parts of the world, such as on the transit from Hawaii to Guam, where the satellite coverage did not overlap.

The CNAV display is located in the rack room. The antenna is located on the starboard side of the flying bridge catwalk.

[1] http://www.cnavgnss.com/site.php

The CNAV is also connected to the POSMV to give the POSMV satellite corrected position information, which then goes into the multibeam. It is also connected to the CTD computer (for use with the XBT), CTD deck unit, single-beam sonar and Knudsen sub-bottom profiler.

Furuno DGPS*:* The Differential Global Positioning System (DGPS) is used primarily as a backup. When we lose CNAV coverage, we will use the DGPS for collecting and transmitting position data.

Figure 3: Furuno DGPS dislplay and antenna.

Position and Orientation System for Marine Vessels (POSMV): The Applanix V4 POS MV Inertial Measurement Unit (IMU) and granite block (reference point) are located on the main deck in the fan room. There is a guard built around the sensor and the block so that both components are protected from damage by loose equipment or crew. The POSMV deck unit is located in the rack room. The POSMV data is sent to SCS as well as the multibeam sonar, the Dynamic Positioning System, and is integrated into Hypack (scientific navigation software) for both multibeam and ROV operations.

Figure 4: POSMV deck unit, IMU and granite block.

Gyro 1 & Gyro 2: The gyros are located on the bridge. This is the only set of ship's navigational equipment that is also connected to SCS.

Figure 5: Gyrocompasses located in the bridge.

Nav Data Outputs:

$--GGA, Global Position System Fix

CNAV, Furuno DGPS, POS MV

Column	Name	Description	Example Data
1	SCS Date	Date data was recorded by SCS	7/8/2010
2	SCS Time	Time date was recorded by SCS	04:23.3
	Sentence Identifier	Global Positioning System Fix Data	$GPGGA
4	Time	GPS Time	170834 = 17:08:34 UTC

6-May	Latitude	Degrees, decimal minutes, N/S	4124.8963,N = 41d 24.8963'N
8-Jul	Longitude	Degrees, decimal minutes, E/W	08151.6838,W = 81d 51.6838'W
9	Fix Quality	The Quality of the GPS Fix: 0 = Invalid 1 = GPS fix 2 = DGPS fix	2
10	# Satellites	Number of satellites tracked	6
11	HDOP	Horizontal Dilution of Precision	1.5
13-Dec	Altitude	Height above sea-level in meters	234.5,M
14-15	Height over WGS84	Height above WGS84 ellipsoid in meters	-25.1,M
16	DGPS stale interval	Time since last DGPS update in seconds	9
17	DGPS Station	ID Number of the DGPS station	25
18	Checksum	2-byte XOR sum of data to check for transmission errors	*4D

$--GLL, Geographic Position, Latitude/Longitude Data

CNAV, Furuno DGPS, POS MV

Column	Name	Description	Example Data
1	SCS Date	Date data was recorded by SCS	7/8/2010
2	SCS Time	Time date was recorded by SCS	04:23.3
3	Sentence Identifier	Global Position, Latitude/Longitude Data	$GPGLL
5-Apr	Latitude	Degrees, decimal minutes, N/S	4124.8963,N = 41d 24.8963'N
7-Jun	Longitude	Degrees, decimal minutes, E/W	08151.6838,W = 81d 51.6838'W
8	Fix Time	Time of position fix UTC	225423 = 22:54:23
9	Data Valid	Is data active (A) or void (V)	A
10	Checksum	2-byte XOR sum of data to check for transmission errors	*4D

$--VTG, Track Made Good and Speed Over Ground

CNAV, Furuno DGPS, POS MV

Column	Name	Description	Example Data
1	SCS Date	Date data was recorded by SCS	7/8/2010
2	SCS Time	Time date was recorded by SCS	04:23.3
3	Sentence Identifier	Track Made Good, Ground Speed	$GPVTG
5-Apr	TMG T	Track made good, True	054.3,T
7-Jun	TMG M	Track made good, Magnetic	032.3,M
9-Aug	SOG N	Speed Over Ground, knots	008.3,N
11-Oct	SOG K	Speed Over Ground, kilometers/hour	016.3,K
12	Checksum	2-byte XOR sum of data to check for transmission errors	*0E

$--HDT, Heading, True

CNAV, Furuno DGPS, POS MV, Gyro 1 & 2

Column	Name	Description	Example Data
1	SCS Date	Date data was recorded by SCS	7/8/2010
2	SCS Time	Time date was recorded by SCS	04:23.3
3	Sentence Identifier	Heading, True	$HEHDT

4	Heading, true	Heading in degrees, true	64.3
5	True Designation	Static Text designating the heading is in reference to true North	T
6	Checksum	2-byte XOR sum of data to check for transmission errors	*2E

$--ROT, Rate of Turn

Gyro 1 & 2

Column	Name	Description	Example Data
1	SCS Date	Date data was recorded by SCS	7/8/2010
2	SCS Time	Time date was recorded by SCS	04:23.3
3	Sentence Identifier	Rate of Turn	$HEROT
4	Rate of turn	Rate of turn in degrees/min, "-" means turning to port	7.8
5	Data Valid	Is date valid (A) or void (V)	A
6	Checksum	2-byte XOR sum of data to check for transmission errors	*7B

$PRDID, RDI Proprietary Heading, Pitch, Roll

POS MV

Column	Name	Description	Example Data
1	SCS Date	Date data was recorded by SCS	7/8/2010
2	SCS Time	Time date was recorded by SCS	04:23.3
3	Sentence Identifier	RDI Proprietary, Heading, Pitch, Roll	$PRDID
4	Pitch	Vessel Pitch in degrees, "+" = bow up.	1.21
5	Roll	Vessel Roll in degrees, "+" = port up	0.12
6	Heading	Vessel Heading in degrees, true	254.32
7	Checksum	2-byte XOR sum of data to check for transmission errors	*7D

$PASHR, Attitude Sensor, INS

POS MV

Column	Name	Description	Example Data
1	SCS Date	Date data was recorded by SCS	7/8/2010
2	SCS Time	Time date was recorded by SCS	04:23.3
3	Sentence Identifier	Attitude Sensor	$PASHR
4	Time	Time (hhmmss.sss) UTC	134500.125
6-May	Heading	Vessel Heading in degrees, true	270.34,T
7	Roll	Vessel Roll in degrees, "+" = port up	0.12
8	Pitch	Vessel Pitch in degrees, "+" = bow up	1.04
9	Heave	Vessel Heave in meters	0.34
10	Roll Accuracy	Roll angle accuracy estimate (stdev) in degrees	0.01
11	Pitch Accuracy	Pitch angle accuracy estimate (stdev) in degrees	0.03
12	Heading Accuracy	Heading angle accuracy estimate (stdev) in degrees	0.05/td>
13	Aiding Status	Unknown	2
14	IMU Status	Unknown	1
15	Checksum	2-byte XOR sum of data to check for transmission errors	*7D

Further Information:

http://www.cnavgnss.com/site.php
http://www.applanix.com/products/marine/pos-mv.html
http://www.furuno.com/
http://www.vttss.com/

Meteorological:

The weather data comes from a suite of sensors located on the flying bridge antenna catwalk. All of these sensors are part of one package serviced by Remote Measurements & Research Company of Seattle, WA. This data is collected in one of two data sentences.

Figure 6: SCS Met Sensor Layout as of 2008. No adjustments have been made since 2008.

Figure 7: (left) Humidity Transmitter (& Air Temperature), Viasala. This sensor measures both temperature and relative humidity. *(right) Barometer port.*

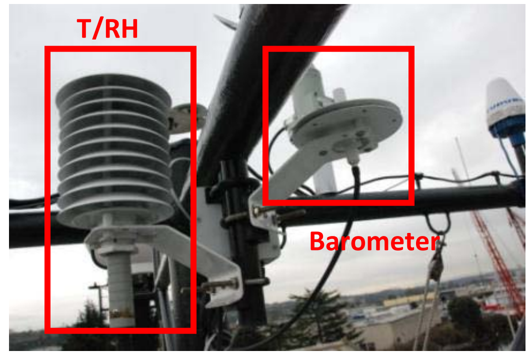


Figure 8: Barometer, RM Young.

The barometer is located on the bridge, but uses a port which runs outside and up the mast, where the opening is next to the air temperature and relative humidity sensor.

Figure 9: Relative Wind Direction and Speed, RM Young.

The 'wind bird' is placed on the centerline of the vessel on the Met mast. True wind is then calculated by SCS by utilizing input from the CNAV, Gyro and Wind Sensor. *Please see the section on derived sensors for more information.*

Figure 10: Radiometer (PIR & PSP), Eppley Laboratory, Inc.

Precision Spectral Pyranometer (PSP) measures shortwave irradiance, and Precision Infrared Radiometer (PIR) measures long wave irradiance.

Met Data Output:

$--MWV, Acoustic Wind Sensor

RM Young & Zeno Met

Column	Name	Description	Example Data
1	SCS Date	Date data was recorded by SCS	7/8/2010
2	SCS Time	Time date was recorded by SCS	04:23.3
3	Sentence Identifier	Acoustic Wind Sensor	$WIMWV
4	Wind Direction	Wind Direction in degrees	154.3

5	Direction Reference	Wind Direction Reference, R = Relative, T = True	R
6	Wind Speed	Wind Speed	16.4
7	Speed Units	Wind Speed Units, K = km/hr, M = m/sec, N = kt	K
8	Sensor Status	Sensor Status, A = Valid, V = Void	A
12	Checksum	2-byte XOR sum of data to check for transmission errors	*0A

$--M01, Zeno Met Sensors

RM Young & Zeno Met

Column	Name	Description	Example Data
1	SCS Date	Date data was recorded by SCS	10/6/2024
2	SCS Time	Time date was recorded by SCS	08:27:40
3	Sentence Identifier	Acoustic Wind Sensor	$WIM01
4	Date	Date (UTC) YY/MM/DD	10/6/2024
5	Time	Time (UTC) HH:MM:SS, end of the averaging period	08:27:40
6	Barometer	Uncorrected, hPa (mbar)	1001.8
7	Sensor Height	(m) above sea level	17.4
8	Measurement Quality	A= okay, X= not okay	A
9	Air Temperature	(°C)	29.38
10	Sensor Height	(m) above sea level	17.4
11	Measurement Quality	A= okay, X= not okay	A
12	Relative Humidity	%RH	73.7
13	Sensor Height	(m) above sea level	17.4
14	Measurement Quality	A= okay, X= not okay	A
15	Vector Mean Relative Wind Speed	(m/s)	15.9
16	Vector Mean Relative Wind Direction	Relative to bow (deg)	78.1
17	Relative Mean Scalar Wind Speed	(m/s)	15.9
18	Relative Wind Maximum	(m/s)	16.2
19	Sensor Height	Wind sensor, (m) above sea level	18.0
20	Measurement Quality	A= okay, X= not okay	A
21	SW, Shortwave irradiance	mean of RAD output (Wm-2)	225.11
22	Sensor Height	Wind sensor, (m) above sea level	18.0
23	Measurement Quality	A= okay, X= not okay	A
24	LW, Longwave irradiance	mean of RAD output (Wm-2)	-32.70
25	Thermopile Voltage, PIR	(mV)	-368.00
26	Case Temperature, PIR	(°C)	32.25
27	Dome temperature, PIR	(°C)	31.99
28	Sensor Height	Radiometer, (m) above sea level	18.0
29	Measurement Quality	A= okay, X= not okay	X
30	Checksum	2-byte XOR sum of data to check for transmission errors	*42

Further Information:

http://www.rmrco.com/
http://www.youngusa.com/
http://www.eppleylab.com/
http://www.vaisala.com/en/pages/default.aspx

Oceanographic:

Scientific Seawater System (SiSwSys): This system was designed to run a continuous flow of seawater through two instruments to measure the properties of the surface water. The intake for this system in is the bow, and the equipment (pump, plumbing and external temperature probe) are all located in the bow-thruster room. All the data from the following sensors are contained in the 'SciSwSys' folder.

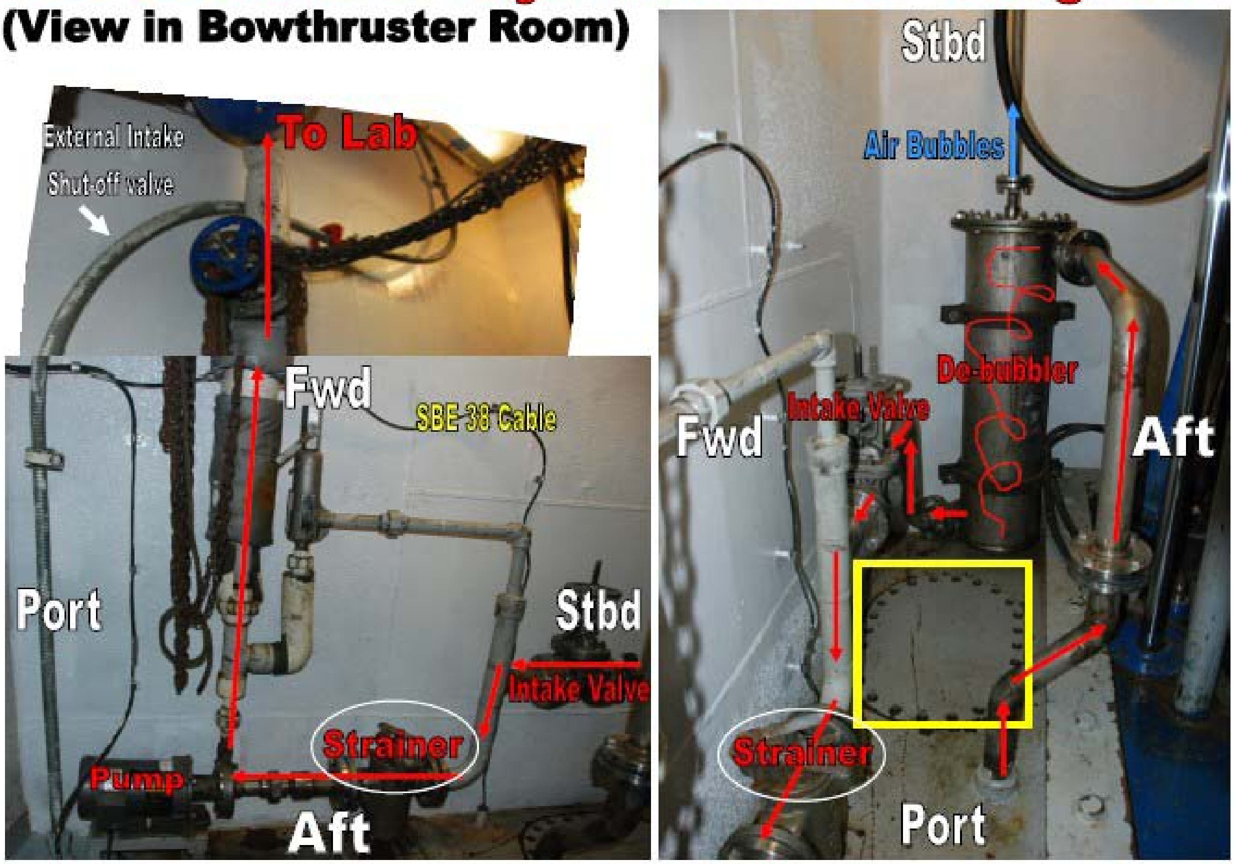
Generally, all sensors are turned on as soon as possible. For example, the scientific seawater system is not turned on until the ship has cleared the harbor. Running the system in an environment prone to chemicals from ships and land facilities can damage the sensitive sensors. Sometimes, when the ship is in rough weather, the seawater system may catch an air bubble, which can disrupt the data, or require the system to be shut down temporarily. These occasions can be easy to identify by plotting the two temperature measurements—if the TSG temperature is high (like 15-20°C) then there is likely no flow in the system, which allows the TSG temperature to increase to room temperature, while the remote probe will stay at ocean temperature.

Figure 11: Position of the scientific seawater system intake, forward of the bow thruster.

A new intake was installed during the December 2010 drydock because the previous one (closer to the waterline) would sometimes catch air while in rough weather, causing a disruption of flow. If the air got stuck in the system, it would require a shut down of the system so that the pump would not burn out from running with no water flow. This new location, at 13' depth (3.96 m) will be tested in 2011.

EX Seawater System Flow Diagram

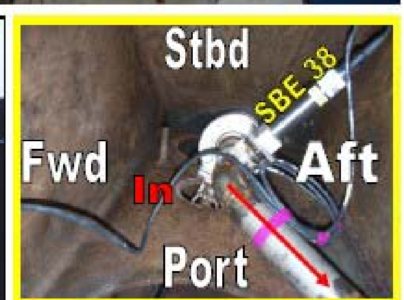
(View in Bowthruster Room)



In **2011 Drydock** a new seawater intake was installed. The new intake was located lower on the bow to prevent the system from catching air bubbles while the ship rides large seas. The intake is now at a depth of 13 feet below the design water-line.

The intake is located in a cofferdam between the bow thruster room and the hull, with the SBE 38 approx. 2 feet above the intake. Water travels from the intake, through the SBE 38 sensor (horizontally mounted), up into the bow thruster room, through a de-bubbler, (where air is removed), past the intake valve, through the strainer, past the pump and up towards the labs.

There is a remote shut-off for the second intake valve, located in the cofferdam. (Official drawings can be made available when completed).



Looking downward from Man-hole cover in bow thruster room into cofferdam between the outer hull and bow thruster room.

(Arrows indicate direction of flow.)

Figure 12: Scientific Seawater System flow diagram from intake through bow thruster room.

Figure 13: *Scientific Seawater System in the EX wetlab. The water comes from the bowthruster room, down the starboard side of the ship, into the wetlab. It then travels first through a de-bubbler (to remove any remaining air), then through a strainer (one is on, the other is off. The second one is turned on so that the first can be turned off for cleaning without disrupting flow). The water then enters the TSG, exits the TSG and is drained overboard. There was a fluorometer, but it was sent out for repairs.*

SBE 38 Remote Temperature Probe: The 'external' or remote probe, SBE 38 measures temperature as close to the system's intake as possible. When we send 'sea surface temperature' data, we primarily use this sensor. This temperature is used to calculate sound velocity with the TSG for use in the multibeam sonar.

Figure 14: *SBE 38 Remote Temperature Probe.*

SBE 45 Micro Thermosalinograph (TSG): The TSG measures temperature and conductivity. With these two measurements, it calculates salinity. With the salinity from the TSG, and the temperature from the remote probe, it calculates sound velocity. Using the remote probe makes sound velocity calculations more accurate because the temperature at the TSG can be affected slightly as it travels through the ship to the wet lab.

Figure 15: *SBE 45 Micro Thermosalinograph.*

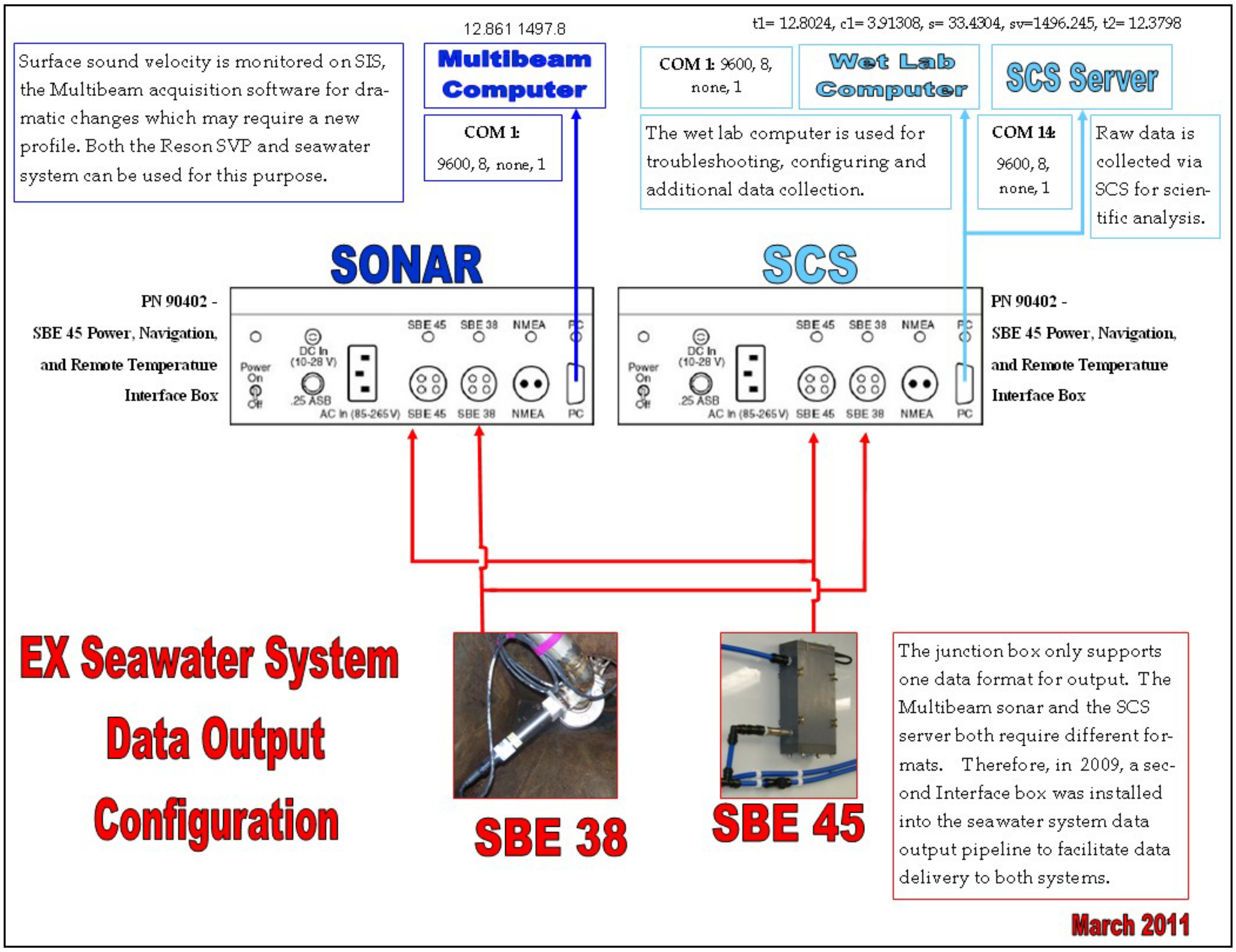


Figure 16: Seawater System Data Output Configuration

Seawater System Data Output:

TSG (COM 14)

SBE 45 Micro Thermosalinograph

Column	Name	Description	Example Data
1	SCS Date	Date data was recorded by SCS	7/8/2010
2	SCS Time	Time date was recorded by SCS	04:23.3
3	t1=	Temperature from TSG in wet lab (°C)	29.373
4	c1=	Conductivity from TSG in wet lab (S/m)	5.62268
5	s=	Salinity from TSG (psu) in Wet Lab	34.0032
6	sv=	Sound Velocity from TSG in wet lab (m/s)	1543.579
7	t2=	Temperature from external probe in bowthruster room (°C)	29.5264

Conductivity Temperature and Depth (CTD): CTDs are standard oceanographic systems on most ocean-going research vessels. This system provides a profile of the water column, measuring the chemical and physical properties of the water.

SBE 9/11 plus CTD is connected to the SBE 32 Carousel. The SBE 32 is rigged with 24-2.5L General Oceanics water sampling bottles. The bottles can be fired to close at any depth during a cast through the Seasave acquisition software on CTD computer in the dry lab or control room. The CTD has dual temperature and conductivity sensors. There are two CTD packages on the EX. One is used for a full season, and the other is reserved as a spare. They are rotated and calibrated each year, so when looking at the data, make sure you are using the appropriate field season guide as a reference to have the correct calibrations and serial numbers.

The CTD has auxiliary ports for up to 8 additional sensors. These may include, but are not limited to, altimeters, Light Scattering, Dissolved Oxygen, and Oxidation Reduction Potential sensors.

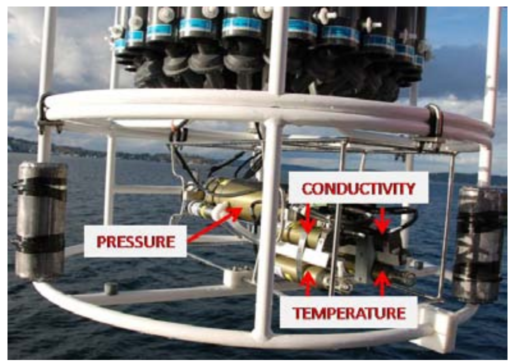


Figure 171. (Left) Deck Unit (SBE 11) for acquisition of real time sound speed profile from SBE 9 plus CTD (Right) Horizontally mounted CTD with dual Temperature and Conductivity sensors and SBE 32 Carousel for 24-bottle water sampling.

CTD Data Output:

CTD (COM 16)*

SBE 9plus with dual T&C (3plus and 4C) plus Aux sensors

Column	Name	Description	Example Data
1	SCS Date	Date data was recorded by SCS	7/8/2010
2	SCS Time	Time date was recorded by SCS	04:23.3
3	Depth	Depth (m)	12.19
4	Pressure	Pressure (db)	12.29
5	Temperature 1	Primary Temperature (°C)	13.86
6	Temperature 2	Secondary Temperature (°C)	13.85
7	Salinity 1	Primary Salinity (psu)	32.15
8	Salinity 2	Secondary Salinity (psu)	32.15
9	Sound Velocity 1	Primary Sound Velocity (m/s)	1499.86
10	Sound Velocity 2	Secondary Sound Velocity (m/s)	1499.84

**The CTD has one standard output in SCS. Although we may have auxiliary sensors from time to time, it is too complicated to change the SCS configuration each time to accommodate the additional sensors. If you need the actual CTD data files in the Seabird formats for processing, please look in the 'profile data' section of this data archive under the appropriate cruise. This folder should contain the raw .hex files as well as the .con files.*

Further Information:

http://www.seabird.com/

http://www.generaloceanics.com/

Sound Velocity Probe: A Reson Sound Velocity Probe was installed during the 2010 drydock. It is located on the starboard side access cover on the transducer fairing, aft of the multibeam receive array. This sensor was installed to provide more accurate sound velocity measurements at the multibeam transducer.

Figure 18. The Reson Sound Velocity Probe (SVP) attached to the access cover on the hull.

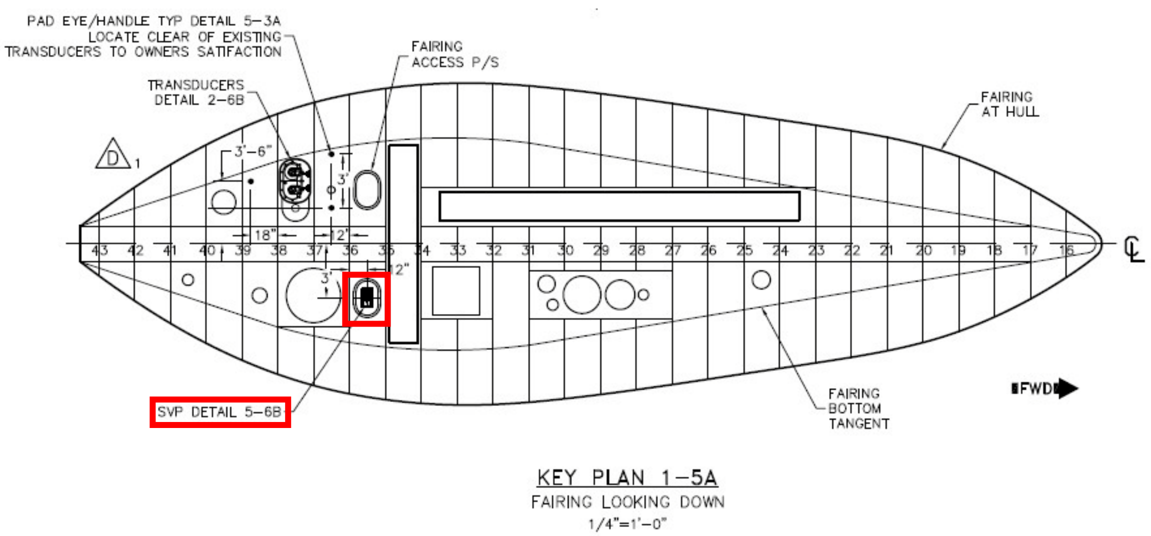
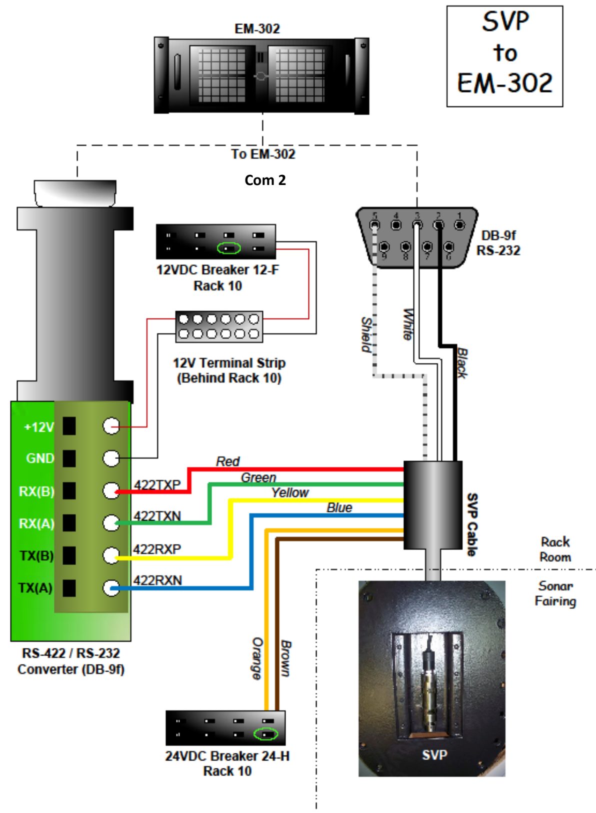


Figure 19. Line drawing showing the placement of the SVP probe on the transducer fairing.

Figure 20. A diagram showing the cable run from the SVP probe to the EM302 computer. The SVP is connected to both the multibeam and SCS.



SVP Data Output:

SVP (COM 36)

Reson Sound Velocity Probe

Column	Name	Description	Example Data
1	SCS Date	Date data was recorded by SCS	7/8/2010
2	SCS Time	Time date was recorded by SCS	04:23.3
3	Sound Velocity	Sound Velocity	1456.99

Further Information:

http://www.reson.com/

Sonars:

Doppler Speed Log: Provides forward/aft (+/-) and port/starboard (+/-) ship speed measurements.

Data Output:

$--DPT, Depth

Furuno Doppler Speed Log, Kongsberg EA 600

Column	Name	Description	Example Data
1	SCS Date	Date data was recorded by SCS	7/8/2010
2	SCS Time	Time date was recorded by SCS	04:23.3
3	Sentence Identifier	Heading - Deviation and Variation	$VDDPT
4	Depth	from transducer, (m)	2128.56
5	Offset from Transducer	+' = distance from transducer to waterline, '-' = distance from transducer to keel	3.4
6	Maximun Range Scale in use	(m)	200
7	Checksum	2-byte XOR sum of data to check for transmission errors	*52

$--VBW, Speed Through Water and Speed Over Ground

Furuno Doppler Speed Log

Column	Name	Description	Example Data
1	SCS Date	Date data was recorded by SCS	7/8/2010
2	SCS Time	Time date was recorded by SCS	04:23.3
3	Sentence Identifier	Speed Through Water and Speed Over Ground	$VDVBW
4	Longitudinal Water Speed	Speed Ahead, through water, "-" means astern (kts)	10.4
5	Transverse Water Speed	Speed to Starboard, through water "-" means port (kts)	0.35
6	Water Data Status	A = Valid, V = Void	A
7	Longitudinal Ground Speed	Speed Ahead, over ground "-" means astern (kts)	8.3
8	Transverse Ground Speed	Speed to Starboard, over ground "-" means port (kts)	0.25
9	Ground Data Status	A = Valid, V = Void	A
10	Stern Transverse water speed	Speed astern through water, "-" means astern (kts)	0.3
11	Stern water speed status	A = Valid, V = Void	A
12	Stern transverse ground speed	Speed astern over ground "-" means astern (kts)	0.3
13	Stern ground speed status	A = Valid, V = Void	A
14	Checksum	2-byte XOR sum of data to check for transmission errors	*1C

Further Information:
http://www.sperrymarine.northropgrumman.com/

Winches:

There are three winches on board. The CTD winch is used for vertical CTD casts or tow-yos (where the CTD package is towed and raised up and down to cover a greater horizontal area). The General Purpose winch is not currently used for anything, but may be in the future. The traction winch is used to support the ROV and camera sled. These sensors are useful to determine the weight of a package, and the depth of the sensors vs. line out for maneuverability and control of the over-the-side ship-handling.

Figure 22: ROV Traction Winch, located below decks in the Traction Winch Room.

Dynacon traction winch system installed below deck equipped with 7500 m of 17mm Rochester 2351 electromechanical cable fitted with the Focal Technologies Corporation Model 176 Electrical Slip Ring combined with the Focal Technologies Corporation Model 242 Fiber Optic Rotary Joint, or equal. The electrical slip ring has four power passes each capable of 5,000 VAC and 10 Amps. The optic rotary joint has 3 single-mode passes. This winch serves as primary umbilical for ROV and camera sled systems. Main control is at traction winch with remote control above ROV hangar and in ROV control room.

Markey Desh-5 Electric Hydrographic Winch installed to support hydrographic operations. Equipped with 8,000 m of 9.5 mm electromechanical cable and level winding system, the Hydro winch will service the A-Frame and J-Frame for complementary over the side operations.

Figure 23: CTD Hyrdowinch, located on the 0-2 deck, aft.

The General Purpose winch is has a non-conductive wire rope. It is located next to the CTD winch, and is a Markey Com-10V.

Winch Data Output:

RD, Winches

ROV Traction Winch, CTD Winch, GP Winch

Column	Name	Description	Example Data
1	SCS Date	Date data was recorded by SCS	7/8/2010
2	SCS Time	Time date was recorded by SCS	04:23.3
3	Sentence Identifier	Winch	RD
4	Tension	(lbs)	27.8621
5	Line Rate	(m/min)	0
6	Line Out	(m)	-6.75666
7	Checksum	Checksum	1533

Further Information:
http://www.dynacon.com/products/dyntrac.html
http://markeymachinery.com/

Derived:

A 'Derived' sensor is one that is created from an existing sensor—there is a mathematical adjustment or calculation made. This is used to calculate the sensor's value in another unit (ex: Relative wind speed is output from the sensor in knots, but if someone needs meters/second then it would be derived). Another example is to calculate true wind. We cannot directly measure true wind on a moving vessel (as the ship moves forward, it creates wind), but we can measure the components that are used to calculate it. SCS takes Ship's SOG, COG, heading, relative wind speed and relative wind direction and calculated true wind direction and speed with a built-in algorithm. Other examples of derived sensors are those that take averages. SCS sends SAMOS and Webship data every day/hour. These data are averaged over a period of time to provide more accurate readings. Taking a snapshot of data would be more prone to outliers, which could negatively impact and improperly represent the data over a period of time.

The following are the data outputs for the current derived sensors:

$DERIV, True Wind

Calculated from RAW Sensor Data

Column	Name	Description	Example Data
1	SCS Date	Date data was recorded by SCS	7/8/2010
2	SCS Time	Time date was recorded by SCS	04:23.3
3	Sentence Identifier	Derived Sensor	$DERIV
4	True Wind Speed	Calculated Value (kts)	15.86
5	True Wind Direction	Calculated Value (deg)	132.12
6	Relative Wind Speed	RM Young (kts)	16.1
7	Relative Wind Direction	RM Young (deg)	79.1
8	SOG	CNAV (kts)	1.75
9	COG	CNAV (deg)	46.8
10	Heading	Gyro 1 (T)	46.8

$DERIV, Relative Wind Spd-ms

Relative Wind Speed (kts) converted to m/s for Webship Data

Column	Name	Description	Example Data
1	SCS Date	Date data was recorded by SCS	7/8/2010
2	SCS Time	Time date was recorded by SCS	04:23.3
3	Sentence Identifier	Derived Sensor	$DERIV
4	Value	Relative Wind Speed (m/s)	8.28
5	Relative Wind Speed	Relative Wind Speed (kts)	16.1

$DERIV, Gyro Difference

Calculated from Gyro 1 & Gyro 2

Column	Name	Description	Example Data
1	SCS Date	Date data was recorded by SCS	7/8/2010
2	SCS Time	Time date was recorded by SCS	04:23.3
3	Sentence Identifier	Derived Sensor	$DERIV
4	Difference Value	Calculated Value (deg)	0.3
5	Gyro 2	Gyro 2 (deg T)	47.1
6	Gyro 1	Gyro 1 (deg T)	46.8

$DERIV, *Various Sensor Averages for SAMOS

SAMOS (FSU) collects climate data in 60 second averages.

Column	Name	Description	Example Data
1	SCS Date	Date data was recorded by SCS	7/8/2010
2	SCS Time	Time date was recorded by SCS	04:23.3
3	Sentence Identifier	Derived Sensor	$DERIV
4	Value	Calculated Average	29.36
5	Base Value	Raw Sensor Value	29.36
6	Sum	Sum of Measured Values	117.44
7	# of values to Average	# of values to Average	4

*Derived Sensors include: Latitude, Longitude, SOG (kts), COG (T), Gyro (T), Air Temperature (°C), Relative Humidity (%RH), Barometric Pressure (mb), Relative Wind Speed (kts), Relative Wind Direction (deg), True Wind Speed (kts), True Wind Direction (deg), TSG Salinity (psu), TSG Conductivity (S/m), TSG Temperature (°C), TSG External Probe Temperature (°C).

$DERIV, *Various Sensor Averages for Webship (NWS)

Webship (NWS) collects Wx data in 2 minute averages.

Column	Name	Description	Example Data
1	SCS Date	Date data was recorded by SCS	7/8/2010
2	SCS Time	Time date was recorded by SCS	04:23.3
3	Sentence Identifier	Derived Sensor	$DERIV
4	Value	Calculated Average	29.36
5	Base Value	Real-time Raw Sensor Value	29.36
6	Sum	Sum of Measured Values	117.44
7	# of values to Average	# of values to Average	4

*Derived Sensors include: Air Temperature (°C), Relative Humidity (%RH), Barometric Pressure (mb), True Wind Speed (kts), True Wind Direction (deg), TSG External Probe Temperature (°C).

$DERIV, TW Line Rate Integer

TW Line Rate * -1 for calculating ROV Time to Surface

Column	Name	Description	Example Data
1	SCS Date	Date data was recorded by SCS	7/8/2010
2	SCS Time	Time date was recorded by SCS	04:23.3
3	Sentence Identifier	Derived Sensor	$DERIV
4	Value	Calculated Value (m/min)	-0.71
5	TW Line Rate	TW Line Rate (m/min)	0.711594

$DERIV, TW Time to Surface

ROV Time to Surface, TW Line Out/TW Line Rate Integer

Column	Name	Description	Example Data
1	SCS Date	Date data was recorded by SCS	7/8/2010
2	SCS Time	Time date was recorded by SCS	04:23.3
3	Sentence Identifier	Derived Sensor	$DERIV
4	Value	Calculated Value (min)	18.63
5	TW Line Out	TW Line Out (m)	341.212
5	TW Line Rate Integer	TW Line Rate (m/min)	18.32

Over time, as data purposes evolve, there may be more derived sensors. These will always be indicated with a $DERIV at the beginning of the raw data. Please contact the survey technicians onboard for questions regarding new or undocumented derived sensors: Chiefst.explorer@noaa.gov

Underway Data Transfers

There are several sets of data that the ship transmits during a cruise:

NOAA Shiptracker

The NOAA shiptracker data is sent hourly via SCS mail message to update the NOAA Shiptracker website. All of the NOAA ships send this message, but the sensor models and content may vary between ships. This message takes a snapshot of the data, there is no averaging, so the data may sometimes look wrong if it catches an error. This message is also sent to National Coastal Data Development Center (NCDDC).

Sensor Value	Parent Sensor	Units
Time	CNAV	(UTC) 170834 = 17:08:34
Latitude	CNAV	4124.8963,N = 41d 24.8963'N
Longitude	CNAV	08151.6838,W = 81d 51.6838'W
Speed Over Ground (SOG)	CNAV	Knots
Course Over Ground (COG)	CNAV	Degrees Magnetic
Heading	Gyro 1	Degrees True
Air Temperature	Viasala	°C
Barometric Pressure	RM Young	mb
Relative Humidity	Viasala	% RH
Relative Wind Speed	RM Young	Knots
Relative Wind Direction	RM Young	Degrees (relative to bow, where bow = 0/360)
True Wind Speed	Calculated by SCS	Knots
True Wind Direction	Calculated by SCS	Degrees True
Sea Surface Temperature	SBE 38 Remote Temperature Probe	°C
Salinity	SBE 45 Micro Thermosalinograph	psu

Further Information:
http://shiptracker.noaa.gov/default.aspx

Webship

A message is sent every hour via SCS mail message to the National Weather Service (NWS) to supplement the manual weather reporting conducted by the ship's officers while on watch on the bridge. This message averages the data over a period of two minutes.

Sensor Value	Parent Sensor	Units
NWS ID	None	NWS0016
Latitude	CNAV	4124.8963,N = 41d 24.8963'N
Longitude	CNAV	08151.6838,W = 81d 51.6838'W
Air Temperature	RMR CO, Zeno Met	°C
Barometric Pressure	RMR CO, Zeno Met	mb
Relative Humidity	RMR CO, Zeno Met	% RH
True Wind Speed	Calculated by SCS	Knots
True Wind Direction	Calculated by SCS	Degrees True
Sea Surface Temperature	SBE 38 Remote Temperature Probe	°C

Further Information:
http://www.vos.noaa.gov/

Shipboard Automated Meteorological and Oceanographic Systems (SAMOS)

SAMOS is at Florida State University. This group does climate studies, and reports to the ship if they find any discrepancies with the sensors or data. This data is collected via an SCS event, and the files that are generated are sent to SAMOS via the SAMOS mailer, built into the SCS menu, on a daily basis. The data that is collected in this event are averaged over a period of 60 seconds.

Sensor Value	Parent Sensor	Units
Call Sign	Metadata	WTDH
Latitude	CNAV	4124.8963,N = 41d 24.8963'N
Longitude	CNAV	08151.6838,W = 81d 51.6838'W
Speed Over Ground (SOG)	CNAV	Knots

Sensor Value	Parent Sensor	Units
Course Over Ground (COG)	CNAV	Degrees Magnetic
Heading	Gyro 1	Degrees True
Air Temperature	Viasala	°C
Barometric Pressure	RM Young	mb
Relative Humidity	Viasala	% RH
Relative Wind Speed	RM Young	Knots
Relative Wind Direction	RM Young	Degrees (relative to bow, where bow = 0/360)
True Wind Speed	Calculated by SCS	Knots
True Wind Direction	Calculated by SCS	Degrees True
Sea Surface (External) Temperature	SBE 38 Remote Temperature Probe	°C
Sea Surface Temperature	SBE 45 Micro Thermosalinograph	°C
Conductivity	SBE 45 Micro Thermosalinograph	S/m
Salinity	SBE 45 Micro Thermosalinograph	psu

Further Information:
http://samos.coaps.fsu.edu/html/

Calibration Documents
In the NODC archive, under the cruise accession, SCS Sensor Calibration documents are located in:

1.1/data/0-data/vessel/Ship_Sensor_Raw_Data/SCS_Data

This will include the scientific seawater system and the meteorological sensors. If an instrument is damaged or defective, it would be replaced during the season, and the documents will be updated in that folder.

The CTD calibration documents can be found in:

1.1/data/0-data/vessel/Ship_Sensor_Raw_Data/Profile_Data/CTD/Calibration Docs

These are separate because the CTD data requires the calibration information for processing. The CTD files will contain the full cast data, which allows further processing for other units, measurements, and auxiliary sensors. As the auxiliary sensors change, they are not included in the SCS data. Only depth, pressure, temperature, salinity and sound velocity are included as standard measurements.

Table of Sensors for the 2011 Field Season:

Sensor Group	Sensor	Make	Model	Precision/Range***	Serial #	Calibration
Navigation	CNAV	C & C Technologies	C-NaviGator 2050	10 cm	5164	N/A
Navigation	POS/MV	Applanix	POS/MV 320 V 4	Position: 0.5 - 2 m, Roll & Pitch: 0.020°, True Heading: 0.020° with 2 m baseline or 0.010° with 4 m baseline. Heave: 5 cm or 5%	2572	N/A
Navigation	DGPS	Furuno	GP-150	GPS: 10 m, DGPS: 5 m, WAAS: 3 m	4415-6302	N/A
Navigation	Gyrocompass	Meridian Standard	929060	Settle Point error: 0.25° secant latitude,Static error: 0.10° secant latitude RMS, Dynamic accuracy: 0.60° secant latitude, Settle point repeatability: 0.25° secant latitude, Follow-up speed: 200°/second, Settling time: 45 minutes, or less to within 0.7°	5217 & 5284	N/A
Meteorological	Wind	RM Young	05106	Wind Speed: 0 to 60 m/s (130 mph), gust survival 100 m/s (220 mph), Wind Direction: 360° mechanical, 355° electrical (5° open)	WM82711	11-24-10
Meteorological	Air Temperature	Viasala	HMP45A	-32.9 to +60°C Temperature.	C4650041	11-11-10
Meteorological	Relative Humidity	Viasala	HMP45A	0.8 to 100% RH	C4650041	11-11-10
Meteorological	Barometric Pressure	RM Young	61202V	600 to 1100 hPa standard range, operating temperature is -50 to +60°C.	BP05149	11-24-10
Meteorological	Shortwave Radiation	Eppley Laboratory, Inc	PSP	Resistance: 680 Ω at 23°C. temperature Compensation Range: -20° to +40°C.	36630F3	12-16-10
Meteorological	Longwave Radiation	Eppley Laboratory, Inc	PIR	Resistance: 671 Ω at 23°C. temperature Compensation Range: -20° to +40°C.	3382F3	1-20-11
Oceanographic	Thermosalinograph	Seabird	45	*Conductivity:* 0-7 S/m (0-70 mS/cm), *Temperature *:* -5 to 35 °C	4545414-0149	05-27-09
Oceanographic	Remote Temperature Probe	Seabird	38	-5 to +35 °C	3845414-0317	12-27-10
Oceanographic	CTD	Seabird	9/11 plus	-5 to +35°C Temperature, 0 to 7 S/m Conductivity, 0 to full scale range (in meters of deployment depth capability): 6800 meters, A/D inputs0 to +5 volts	09P47490-0905	12-27-09
Oceanographic	Temperature	Seabird	3plus	-5.0 to +35 °C range, ± 0.001 °C accuracy	03P5001	12-27-09
Oceanographic	Temperature	Seabird	3plus	-5.0 to +35 °C range, ± 0.001 °C accuracy	03P5017	12-27-09

Sensor Group	Sensor	Make	Model	Precision/Range***	Serial #	Calibration
Oceanographic	Conductivity	Seabird	4C	0.0 to 7.0 Siemens/meter (S/m) range, 0.0003 S/m accuracy	43449	12-27-09
Oceanographic	Conductivity	Seabird	4C	0.0 to 7.0 Siemens/meter (S/m) range, 0.0003 S/m accuracy	43451	12-27-09
Oceanographic	Dissolved Oxygen	Seabird	43	120% of surface saturation in all natural waters, fresh and salt	2100	03-31-11
Oceanographic	ROV CTD	Seabird	FastCat 49	-5 to +35 °C Temperature, *Conductivity* 0 to 9 S/m, *Pressure* 0 to 7000 meters.	0115	11-23-09
Oceanographic	Sound Velocity Probe	Reson	*SVP70*	Range: 1350-1800m/s; Resolution: 0.01m/s; Accuracy (0-50m) ±0.05m/s.	2410039	9-29-10
Sonar	Doppler Speed Log	Sperry	*SRD-500*	Speed range: Fore-Aft: -10.0 to +40 knots through-the-water.	06075991010	N/A
Winch	CTD Winch	Markey	Desh-5	8,000 m of 9.5mm electromechanical cable.	19457	Per cast*
Winch	Traction Winch	Dynacon	Storage Winch	7500 m of 17mm Rochester 2351 electromechanical cable.	9671055 SW	Per cast*
Winch	General Purpose Winch	Markey	Com-10V	9,840m of ¼" 3x19 wire rope.	19905	Per cast*

*The winches are 'zeroed' at the beginning of a cast. When the package is at the water's surface, the counter is set to 0000 meters so that the line out will be correct.

*** Numbers obtained from product manuals.

Data Management:

The following is the organization structure for the raw SCS data, both on the ship and in the archive. This includes the first level folder (in bold), the sensors and their respective sentences:

NAV:

- CNAV
    - GGA
    - VTG
- DGPS
    - GLL
    - VTG
- GYRO 1
    - HDT
    - ROT
- GYRO2
    - HDT
    - ROT
- Gyro-Diff
- POSMV

  - GGA
  - SHR
  - VTG
  - DID

METOC:
- CTD
- CTD Winch
- Doppler
  - Depth
  - DPT
- Flowmeter (not available)
- Fluorometer (not available)
- GP Winch (not used)
- MET (Air Temp, Baro, RelH, Ratiation)
- RelWindSpd (meters per second, derived)
- Sound Velocity Probe
- True Wind (Derived)
- TSG (Conductivity, Temperature, Salinity, Sound Velocity)
- Wind (Relative Direction and Speed)

VEHICLE:
- CP
  - GPGGA
  - GPHDT
  - PGSSRVC
- ROV
  - GPGGA
  - GPHDT
  - PGSSRVR
  - CTD
- Traction Winch
- TW-LineRate Integer (Derived)
- ROV-Time to Surface (Derived)

MAILER:
- SAMOS (Derived)
- Webship (Derived)

ROUTER:
- High Speed
- Low Speed

EVENT DATA (SAMOS only):
- Button Activity.txt
  - Stop and start of event
- MetaDataSensorDescription.csv
  - Header and respective equipment name (name given to sensor in SCS)
- Event Report File
  - Starting values, units for each sensor.

- Samos.txt
- SAMOS_###.hdr
- SAMOS_###.txt
- SAMOS-OBS_###.elg
    - Actual data file, comma delineated.

Contacts:

For questions regarding the ship, sensors and layouts, contact:
Chiefst.explorer@noaa.gov

For questions regarding SCS software and development, contact:
John.katebini@noaa.gov