doi: 10.25923/9vs2-pw48

NOAA Ship *Okeanos Explorer*
NOAA Office of Ocean Exploration and Research
2016 Mapping Systems Readiness Report

Report Contributors:

PS Meme Lobecker[1]
PS Derek Sowers[1]
PS Lindsay McKenna[1]
LT Emily Rose[2]
Jennifer Johnson[3]
SST Rita Bowker[4]

27 October 2016

[1]NOAA Office of Ocean Exploration and Research
[2]NOAA Ship Okeanos Explorer
[3]NOAA Northeast Fisheries Science Center
[4]NOAA Office of Marine and Aviation Operations

NOAA Office of Ocean Exploration and Research
1315 East-West Highway, SSCM3, #10210
Silver Spring, MD 20910

NOAA Office of Marine and Aviation Operations (Atlantic)
439 West York Street
Norfolk, VA 23510-1145

Introduction

The NOAA Office of Ocean Exploration and Research and NOAA Ship *Okeanos Explorer*

Commissioned in August 2008, NOAA Ship *Okeanos Explorer* is the nation's only federal vessel dedicated to ocean exploration. With 95% of the world's oceans left unexplored, the ship's combination of scientific and technological tools uniquely positions it to systematically explore new areas of our largely unknown ocean. These exploration cruises are explicitly designed to establish baseline ecological characterizations of new areas, generate hypotheses, and lead to further investigations by broader scientific community.

Using a suite of seven scientific sonars, two deep water remotely operated vehicles, and telepresence technology, *Okeanos Explorer* provides NOAA the ability to foster scientific discoveries by identifying new targets in real time, diving on those targets shortly after initial detection, and then sending the information back to shore for immediate near-real-time collaboration with scientists and experts at the Exploration Command Centers around the world. The subsequent transparent and rapid dissemination of information-rich products to the scientific community ensures that discoveries are immediately available to experts in relevant disciplines for research and analysis.

In partnership with *Okeanos Explorer*, NOAA's Office of Ocean Exploration and Research (OER) provides the nation with unparalleled capacity to discover and investigate new oceanic regions and phenomena, conduct basic research required to document discoveries, and seamlessly disseminate data and information-rich products to a multitude of users. The program strives to develop technological solutions and innovative applications to critical problems in undersea exploration and to provide resources for developing, testing, and transitioning solutions to meet these needs.

Okeanos Explorer Management - a unique partnership within NOAA

OER combines the capabilities of the NOAA Ship *Okeanos Explorer* with shore-based high speed networks and infrastructure for systematic telepresence-enabled exploration of the world ocean. The ship is operated and managed by NOAA's Office of Marine and Aviation Operations, which includes commissioned officers of the NOAA Corps and civilian wage mariners. OER owns and is responsible for operating and managing the cutting-edge ocean exploration systems on the vessel (mapping, ROV, and telepresence) and ashore including Exploration Command Centers and terrestrial high speed networks. The ship and shore-based infrastructure combine to be the only federal program dedicated to systematic telepresence-enabled exploration of the planet's largely unknown ocean.

Contents

Document Purpose

This document describes the mapping capabilities of NOAA Ship Okeanos Explorer, and the performance evaluations undertaken in preparation for the 2016 field season. This report will provide a comprehensive list of all hardware and software components, configuration, calibrations and system evaluations in use during the 2016 field season.

Vessel General Specifications

The vessel was transferred to NOAA from the US Navy in 2004, and underwent extensive refurbishment from 2005-2008. Todd Pacific Shipyards Corporation and Fairhaven Shipyard added the ROV hangar, bow and stern thrusters, the fairing for scientific mapping sonars, and upgraded the bridge. During that period, the ship was outfitted with a deepwater multibeam echosounder (MBES), a singlebeam echosounder (which has since been removed), and a subbottom profiler (SBP), along with a host of ancillary equipment. Additional ship specifications can be found at http://www.moc.noaa.gov/oe/index.html (last accessed 1/26/16).

Designer	Halter Marine	*Range (nm)*	9600
Builder	VT Halter Marine, Moss Point MS	*Endurance (days)*	40
Launched	Oct. 28, 1988	*Endurance constraint*	Food
Delivered to NOAA	Sept. 10, 2004	*Berthing*	46
Commissioned	Aug. 13, 2004	*Commissioned Officers*	6
Length (LOA - ft.)	224	*Licensed Engineers*	3
Breadth (moulded - ft.)	43	*Unlicensed Engineers*	3
Draft Maximum (ft.)	16.83 bow thruster retracted; 20.08 bow thruster lowered	*Deck Crew*	7
Depth to main deck (ft.)	5.92	*Survey Technician*	1
Displacement	2062 tons (int'l)	*Electronics Technician*	1 or 2
Emergency Speed (kts)	12	*USPHS Medical Officer*	1
Cruising Speed (kts)	8	*Stewards*	3
Mapping Speed (kts)	8-10)	*Mission Personnel*	20 or 21

Table 1. Table of general vessel specifications.

Sonar Systems

Equipment Category	*Manufacturer*	*Equipment Name*	*Install Date*	*Location on hull*
30 kHz Multibeam Echosounder	Kongsberg Maritime	EM 302	3/2008	Fairing Port - Tx: Fr 23.5 - 33.5; Rx Fr 34-35
18 kHz Splitbeam Echosounder	Simrad	EK 60 / ES18	6/2011	Fairing Port- Fr 39 - 40
38 kHz Splitbeam Echosounder	Simrad	EK 60 / ES38B	12/2016	Fairing Stbd- Fr 29 - 30
70 kHz Splitbeam Echosounder	Simrad	EK 60 / ES70-7C	12/2016	Fairing Stbd- Fr 28
120 kHz Splitbeam Echosounder	Simrad	EK 60 / ES120-7C	12/2016	Fairing Stbd- Fr 30

333 kHz Splitbeam Echosounder	Simrad	EK 60 / ES333-7C	12/2016	Fairing Stbd- Fr 28-29 IB
3.5 kHz Subbottom Profiler	Knudsen Engineering	Chirp 3260	2008	Fairing Stbd- Fr 32 - 34
38 kHz Acoustic Doppler Current Profiler	Teledyne RD Instruments	Ocean Surveyor (OS38)	12/2016	Fairing Stbd-Fr 36-38
300 kHz Acoustic Doppler Profiler	Teledyne RD Instruments	Workhorse Mariner (WH300)	12/2016	Fairing Stbd-Fr 38-39

Table 2. Table of scientific sonar systems on NOAA Ship *Okeanos Explorer*.

Multibeam Echo Sounder (MBES)

The Okeanos Explorer is equipped with a Kongsberg Maritime EM 302 multibeam sonar system. The transducers were mounted on the hull by Todd Shipyard in Seattle in 2006/2007, and was accepted after field September 2008 field testing. The transducers are mounted in a Mills Cross formation on a scientific sonar transducer fairing. The topside electronics (transceiver unit) is located in an enclosed, temperature controlled closet in the ship's library. The EM 302 control and acquisition work station is located in the main Mission Control Room on the 01 deck. A remote on/off switch is located next to the workstation. The Hydrographic Workstation computer, which controls the system, is located in the rack room.

The nominal frequency of the EM 302 is 30 kHz. The system can be operated in two modes, Continuous Waveform (CW) or Frequency Modulated (FM). FM mode offers the distinct advantage of acquiring larger swaths in deep water than traditional 30 kHz multibeam sonars. In water shallower than 3300 meters, the sonar utilizes multi-ping technology to obtain two swaths per ping, resulting in increased along track sounding data density.

This system provides three data types: (1) high resolution bathymetry, (2) bottom backscatter, and (3) water column backscatter.

Due to the geographically remote nature of much of Okeanos' work, a comprehensive set of spare parts for the multibeam transceiver unit is carried onboard, as well as a spare Hydrographic Workstation.

An annual patch test is conducted to calibrate the angular offsets between the multibeam and positioning and timing equipment.

The following table provides observed swath coverage from 2011 and 2012 in various environmental conditions.

Nadir Depth (m)	Vessel Speed (kts)	Ship Heading	Wind Speed / Predominant Direction	Swell Height / Predominant Direction	Swath Coverage (km)	Coverage as a Function of Water Depth

500	9	220°	33 kts / 10°	8-10 ft / 10°	2	4x
1000	7.7	268°	10-12kts / 280°	8-10 ft / 280°	4.2	4.2x
1000	8.1	90°	10-15 kts / 310°	8 ft / 280°	5.5	5.5x
1000	10	36°	13 kts / 200°	2-3 ft / 10°	5.6	5.6x
1500	8	220°	10 kts / 230°	3-4 ft / 10°	6	4x
2000	7.7	90°	10-15 kts / 310°	8 ft / 280°	7.7	3.9x
2000	8	268°	10-12kts / 280°	8-10 ft / 280°	7	3.5x
2000	10	194°	10 kts / 0°	3-4 ft / 20°	6.6	3.3x
2500	10	228°	16 kts / 30°	3-4 ft /30°	7.5	3x
3000	7.5	268°	10-12kts / 280°	8-10 ft / 280°	6.9	2.3x
3000	7.7	90°	10-15 kts / 310°	8 ft / 280°	7.3	2.4x
4000	8	90°	10-12 kts / 280°	8 ft / 280°	7.5	1.9x
4000	8.5	268°	10-12kts / 280°	8-10 ft / 280°	7.3	1.8x

Table 3. Table of observed EM 302 swath coverage.

Water Column Splitbeam Echo Sounders

The ship has five operational Kongsberg EK 60 splitbeam echosounders. The 18 kHz system was added to the ship during the 2010/2011 winter inport. The 38, 70, 120, and 200 kHz systems were added to the ship during the 2015/2016 winter inport. A 333 kHz transducer is also installed in the hull, but currently no GPT rack unit is available to operate it.

The splitbeam echosounders can be run simultaneously or separately, and in different modes including an active and passive mode. Together, they are able to collect biotic and abiotic water column data. Complimentary to the EM302 water column data, the EKs can provide calibrated water column backscatter for areas of interest. All frequencies installed are accepted and used by fishery scientists by locating and characterizing fish aggregations and individual target strengths of fish species. Specifically, the 38 kHz is the primary frequency used by all fisheries research vessels throughout the world, and the optimal frequency by which to compare data. In addition, the EK60's allow researchers studying bubble plumes to analyze shallow and deep water gas seeps in a quantifiable way. All frequencies will be calibrated regularly depending on water conditions of the survey area. Various areas of data collection can be replayed with calibrated settings applied.

Subbottom Profiler (SBP)

The Knudsen 3.5 kHz Chirp 3260 subbottom profiler was installed during the initial conversion in 2008, and was accepted in November 2008. The system is capable of collecting subbottom profiles of up to ~80 meters below the seabed at full ocean depth, as demonstrated during 2015 data collection over the Puerto Rico Trench.

Acoustic Doppler Current Profilers (ADCP)

Two ADCPs were added to the ship's sonar suite during the winter inport in 2015/2016 at Bay Ship and Yacht in Alameda. Both systems were accepted during EX-16-01 Harbor Acceptance Testing and Sea Acceptance Testing. ADCPs provide detailed maps of water currents and suspended material through the water column along the ship's path. They also provide situational awareness when conducting over the side work. The University of Hawaii Data Acquisition System (UHDAS) is used to collect ADCP data.

The Ocean Surveyor 38 kHz ADCP is capable of collecting current profiles up to 1000 meters to ~1300 meters below the sea surface at vertical resolutions of 4 meters to 24 meters. The system can be operated in long range mode and high precision mode simultaneously and can measure current velocities from -5 to 9 meters/second.

The Workhorse Mariner 300 kHz ADCP is capable of collecting current profiles up to ~100 meters below the sea surface at vertical resolutions of 0.25 meters to 8 meters.

ADCP Unit	Max Range (m)	Vertical Resolution Cell Size (m)
OS38 Long Range Mode	>1000	4 - 24
OS 38 High Precision Mode	>950	" "
WH300 Mariner	~70	0.25 - 8

Table 4. Table describing ADCP capabilities.

Sonar Synchronization

A Mace Trigger Jigger is used to synchronize the multibeam, 18 kHz EK 60, and subbottom profiler, and subsequently all three are run simultaneously during mapping operations. At the time of writing this report, interference was observed between the other EK 60 frequencies and the multibeam, as well as the 38 kHz ADCP and the multibeam, and alternative methods for synchronization, as well as Trigger Jigger reconfiguration were being pursued.

Transducer Maintenance

During the 2015/2016 winter in port, all transducers were thoroughly and carefully cleaned by hand with bamboo scrapers, soft scrubbers, and vinegar, according to sonar manufacturer guidance. Where appropriate, the marine grade epoxy at the fairing/transducer interface was replaced according to sonar manufacturer recommendations. The transducers were also coated with an anti-fouling paint as recommended by the manufacturers.

Periodically throughout each field season, the scientific sonar fairing is inspected by NOAA divers for the presence of biofouling and to determine the condition of the epoxy and anti-fouling paint. As necessary, transducers are scraped by divers with bamboo scrapers and soft scrubbers to maintain optimal performance.

Positioning, Orientation and Time Synchronizing Equipment

Vessel Motion

A POS M/V version 5 was installed during the 2015/2016 winter inport, which provides position, heading, attitude, and heave data for the vessel. The system includes a POS computer system (rack unit), an internal motion unit (IMU), and two GPS antennas. The IMU is located under a protective steel box in the fan room on the main deck. Satellite DGPS correctors are provided to the POS from the CNAV 2050.

Bridge Dynamic Positioning System

Okeanos Explorer is equipped with Kongsberg Dynamic position (DP) that has been integrated with the navigation system to help *Okeanos Explorer* maintain her position at meter-level accuracy during ROV operations using bow and stern thrusters. The DP system is also capable of running predefined survey track lines with minimal supervision.

Sound Speed Measurement

UnderwayCTD

An UnderwayCTD was added to the ship during the 2015/2016 winter inport. The UnderwayCTD (http://www.oceanscience.com/Products/UnderwayCTD/Underway-CTD.aspx) manufactured by Teledyne Oceanscience is piece of equipment used to gather conductivity/temperature/depth (CTD) measurements or sound velocity measurements while the ship is moving. The instrument is mounted on the stern railing and has a re-usable probe that is dropped through the water column then retrieved by rewinding the line onto a motorized spool. The unit can be equipped with a CTD probe or a sound velocity probe. When equipped with the sound velocity probe, the UnderwayCTD can obtain water column profiles down to over 700 meters while the ship is moving at 8 knots. The slower the ship goes, the deeper the cast that can be collected. The SV probe has a faster descent rate and can therefore collect a deeper cast than the CTD probe at equivalent ship speeds. The probes are connected to the winch with a 500lb test 1500 yard line. Approximately 500 meters of line are wound on to a tail spool that is attached to the probe and enables the probe to fall for most of the cast with minimal line drag.

The UCTD on the *Okeanos Explorer* has the following probe options:

- Training probe system for training purposes. Includes training probe and tail spool (1)

- Underway CTD Probe and Tail Spool Assembly (1 probe)

- Rapid SV Probe and Tail Spool Assembly (2 probes, one primary, one spare)

Expendable Bathythermographs (XBTs)

Lockheed Martin Sippican XBTs are conducted on the aft deck with a portable launcher. "Deep Blue" probe types are used, which collect data to 760 meters depth and can be deployed at survey speed. Three launchers and enough probes for a field season are kept onboard.

Seabird CTD

Okeanos Explorer has two Sea-Bird electronics, Inc. (SBE) 9/11Plus CTDs, each with dual "3plus Temperature" and "4C Conductivity" sensors. "3plus Temperature" sensors are certified by Seabird to demonstrate temperature measurement drift of less than 0.001 °C and time measurement accuracy within 0.065 ± 0.010 seconds. "4 C Conductivity" sensors are ideally suited for obtaining horizontal data with towed systems or vertical data with lowered systems.

This unit collects temperature, conductivity, and pressure in real time and depth, salinity and sound velocity are calculated in real time via SBE Seasave acquisition software. One complete package is

used to collect data and the other is kept as a spare. When necessary, the ship can hold station in DP to conduct a CTD cast. The CTD is lowered through the water column at 60m/min.

The ship successfully tested Tow-Yo capabilities during the 2011 field season. Tow-Yos can be conducted in up to 2500 meters of water while the ship utilizes its dynamic positioning system to maintain precise Tow-Yo tracklines.

The primary Seabird CTD sensor for the 2016 field season is SBE-0Plus CTD. Calibration information can be obtained by contacting the ship.

Teledyne Reson SVP-70

The primary surface sound speed sensor is a Teledyne Reson Sound Velocity Probe (SVP 70). During the 2015/2016 winter inport, it was moved to the port hatch near the EM 302 transmit array. One spare is carried onboard and is wet mountable.

Thermosalinograph (TSG)

A TSG is used as the backup system for measuring surface sound speed. A component of the onboard scientific seawater system, the TSG collects temperature and conductivity readings, and derives salinity and sound velocity in realtime. The value is computed by the system, and provided directly to the multibeam Hydrographic Workstation. The system is fully described in the water sampling section below.

Water Sampling

Scientific Seawater Measurement System

The scientific seawater system utilizes a SBE 45 Thermosalinograph (TSG) and an SBE 38, to collect continuous sea surface temperature and salinity data. Located in the Wet Lab, the TSG collects temperature and conductivity readings, and derives salinity and sound velocity data in real time. The pump and the SBE 38 are located in the bow thruster room. The pump intakes water from eleven feet below the water line into the bow thruster room, where a SBE 38 Remote Temperature Sensor acquires sea surface temperature. Afterwards, the water continues aft to the wet lab where it passes through the SBE 45 and is expelled on the port side below and a little forward of the wet lab.

Vessel Offsets and Lever Arms

The sensors (IMU and GPS antennas), the sonar system, and permanent benchmarks were measured with respect to the vessel's reference point (RP), which is the granite block located in the fan room on the main deck. The ship was surveyed in 2008 by Westlake Consultants, Inc. The resultant preliminary report "Report of Sonar Systems and GPS Antennae as-builting on the NOAA *Okeanos Explorer*" March 18, 2008 [2] summarizes Westlake Consultant's survey methodology, defines the coordinate system and details the offsets measurements. All measurements described within the report are referred to the granite block and follow the coordinate system where all values--STBD (Y), FWD (X) and down (Z) of the granite block--as positive. Positive pitch is

described as bow up and positive roll is described as STBD up. In 2015, the POSMV DGPS antennas were elevated above a new light shield and were resurveyed. The port antenna is primary.

Based on the 2008 survey, the multibeam transducers locations are entered into SIS under Installation Parameters>Locations as follows.

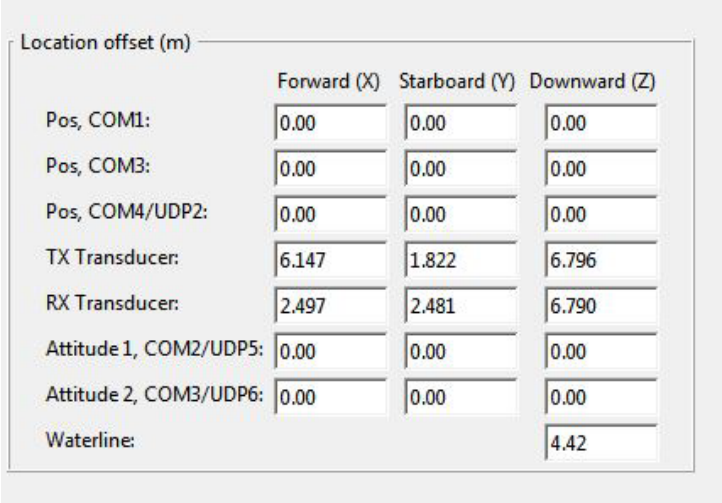


Figure 1. Multibeam transducer locations from 2008 Westlake ship survey, as entered in SIS.

The ship's center of gravity changes with ship loading conditions. The position of the center of the gravity is available from the records of the ship's inclining experiment done in 2008. To determine lever arm offsets, the center of gravity was assumed to be a reasonable approximation of the center of rotation. The position of the ship's center of gravity based on light conditions detailed in the Stability Test report, was measured to be 31.501 m aft of the forward perpendicular (frame 0), 0.0 m starboard of the center line, and 5.514 m above the keel base line. These values were transformed into the POS/MV reference frame with reference to the RP.

Granite Block (Reference Point) to Center of Gravity (rotation) (meters)		
NORTHING (X)	EASTING (Y)	ELEVATION (Z)
-7.896	2.487	0.825

Table 5. Granite Block (Reference Point) to Center of Gravity (rotation).

The POS GPS antenna to reference point lever arms are accounted for in the POS/MV controller. A base plate was installed under the new POSMV v5 IMU and changed the IMU elevation by 0.012m.

DESCRIPTION	NORTHING (X)	EASTING (Y)	ELEVATION (Z)
Granite Block	0.000	0.000	0.000
IMU	0.734	0.008	-0.034

STBD GPS	8.239	3.577	-17.073
PORT GPS (PRIMARY)	8.232	1.275	-17.060

Table 6. Offsets: POS-MV antennas and IMU offsets to granite block.

DESCRIPTION	NORTHING (X)	EASTING (Y)	ELEVATION (Z)
Granite Block	-0.734	-0.008	0.022
IMU	0.000	0.000	0.000
STAR GPS	7.505	3.569	-17.051
PORT GPS	7.498	1.267	-17.038

Table 7. Offsets: POS-MV antennas and granite block offsets to IMU.

POS /MV Coordinates			
	X	Y	Z
Primary GPS (Port Ant.)	8.265	1.335	-15.403
Ref to IMU	0.734	0.008	-0.022
Ref to Aux 1 GPS (C-NAV)	8.353	5.927	-15.396

Table 8. POS MV settings for offsets to primary GPS, auxiliary GPS (C-NAV), and IMU.

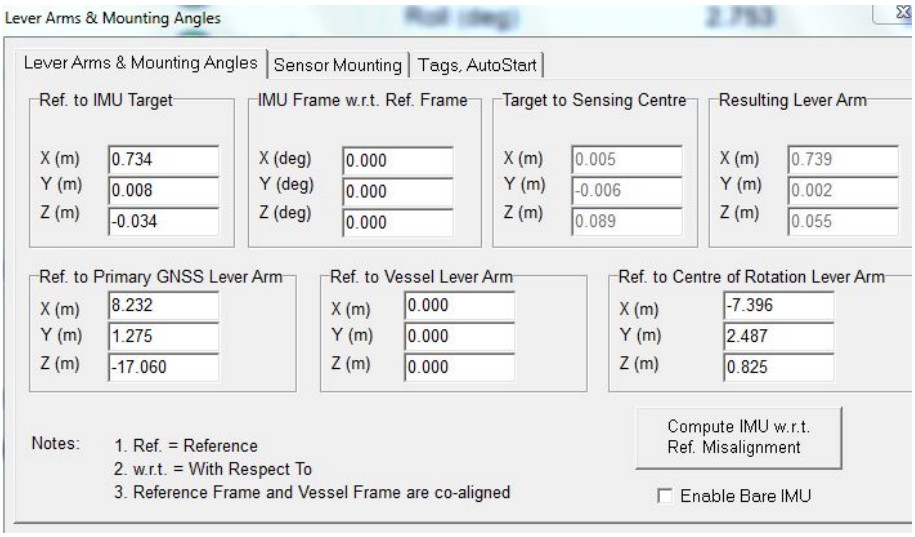


Figure 2. Lever arms as entered in POS Controller.

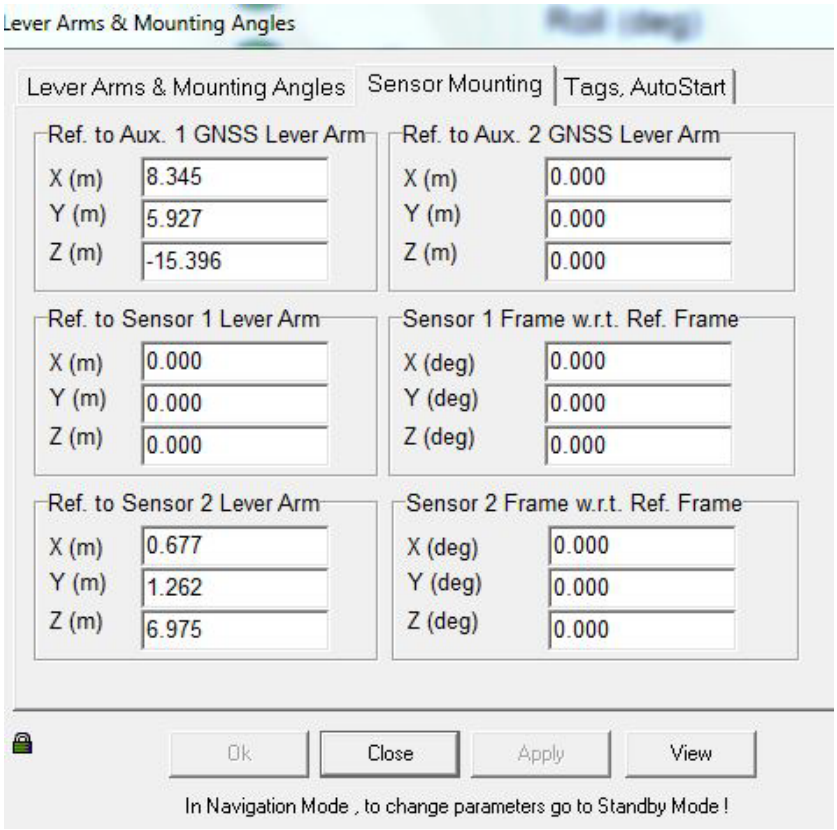


Figure 3. Sensor mounting angles as entered in POS Controller.

Static Draft

The static draft if measured by the bridge before the start of each cruise and the information is included in every mapping data report. The bow draft is directly read off draft marks on the hull and the stern draft is measured and then calculated from a specific frame on the fantail. These draft measurement are then compared to and verified with the results from the ship's stability calculations.

Draft measured for this shakedown cruise were:

- start of cruise: forward 15', aft 14'8"
- end of cruise: forward 15'3", aft 14'2"

System Calibrations and Performance Evaluations

Multibeam Patch Test

A multibeam patch test was conducted offshore from Hawaii. Lines were analyzed independently by four physical scientists using the Caris 9 Calibration Tool. The files/lines used and results are provided below.

Table 9. Lines used for multibeam patch test.

Line	Heading	Average Speed (knots)	Calibration Type
0223_20160206_025720_EX1601_MB.all	302°		Pitch
0224_20160206_033312_EX1601_MB.all	122°	8.3	Pitch/Latency
0225_20160206_041058_EX1601_MB.all	302°	7.2	Heading
0226_20160206_045037_EX1601_MB.all	122°	4.3	Latency
0228_20160206_060547_EX1601_MB.all	301°	8.6	Heading
0232_20160206_223650_EX1601_MB.all	357°	7.3	Roll
0233_20160206_230659_EX1601_MB.all	176°	7.3	Roll
0234_20160206_233908_EX1601_MB.all	356°	7.4	Roll (confirmation line)

Table 10. Calibration offsets from 2016, entered into SIS.

Offset Type	Value
Latency	0.0 seconds
Pitch	-0.725°
Heading	0.0°
Roll	0.0°

Crossline Analysis

Efforts are made to run multibeam crosslines on every cruise throughout the year to ensure data quality. Crossline results are analyzed in Caris.

2016 EK 60 Calibration

A Kongsberg engineer was onboard to calibrate the EK 60 sonars in Hawaii in preparation for the 2016 field season in Pacific warm waters. The calibrations were conducted using the most frequently used pulse length and power settings expected for data collection in 2016. The 333 kHz calibration required three attempts in order to obtain confident results, in part due to the presence of a tiny knot on the line from which the calibration sphere was suspended.

The following calibration files are in the EX1601 EK 60 dataset archived with NCEI.

Frequency 70 kHz; Pulse Length 1.024 ms; Power 750 watts

70Khz_SN-343_1.024ms_750W/70_Cal_Results.png
70Khz_SN-343_1.024ms_750W/70Khz_Cal.txt
70Khz_SN-343_1.024ms_750W/EX1601_EK60_70Khz_SAT-D20160203-T195730.bot/.idx/.raw
70Khz_SN-343_1.024ms_750W/EX1601_EK60_70Khz_SAT-D20160203-T202446.bot/.idx/.raw

Frequency 120 kHz; Pulse Length 1.024 ms; Power 250 watts

120Khz_SN-1256_1.024ms_250W/120_Cal_Results.png
120Khz_SN-1256_1.024ms_250W/120Khz_Cal.txt
120Khz_SN-1256_1.024ms_250W/EX1601_EK60_120Khz_SAT-D20160203-T221119.bot/.idx/.raw

Frequency 200 kHz; Pulse Length 1.024 ms; Power 150 watts

200Khz_SN-596_1.024ms_150W/200_Cal_Results.png
200Khz_SN-596_1.024ms_150W/200Khz_Cal.txt
200Khz_SN-596_1.024ms_150W/EX1601_EK60_200Khz_SAT-D20160203-T203957.bot/.idx/.raw

Frequency 333 kHz Calibration Attempt 1; Pulse Length 1.024 ms; Power 50 watts

333Khz_SN-188_1.024ms_50W/333Khz_Cal.txt
333Khz_SN-188_1.024ms_50W/333Khz_Results.png
333Khz_SN-188_1.024ms_50W/EX1601_EK60_333Khz_SAT_Data-D20160204-T191939.bot/.idx/.raw

Frequency 333 kHz Calibration Attempt 2; Pulse Length 1.024 ms; Power 50 watts

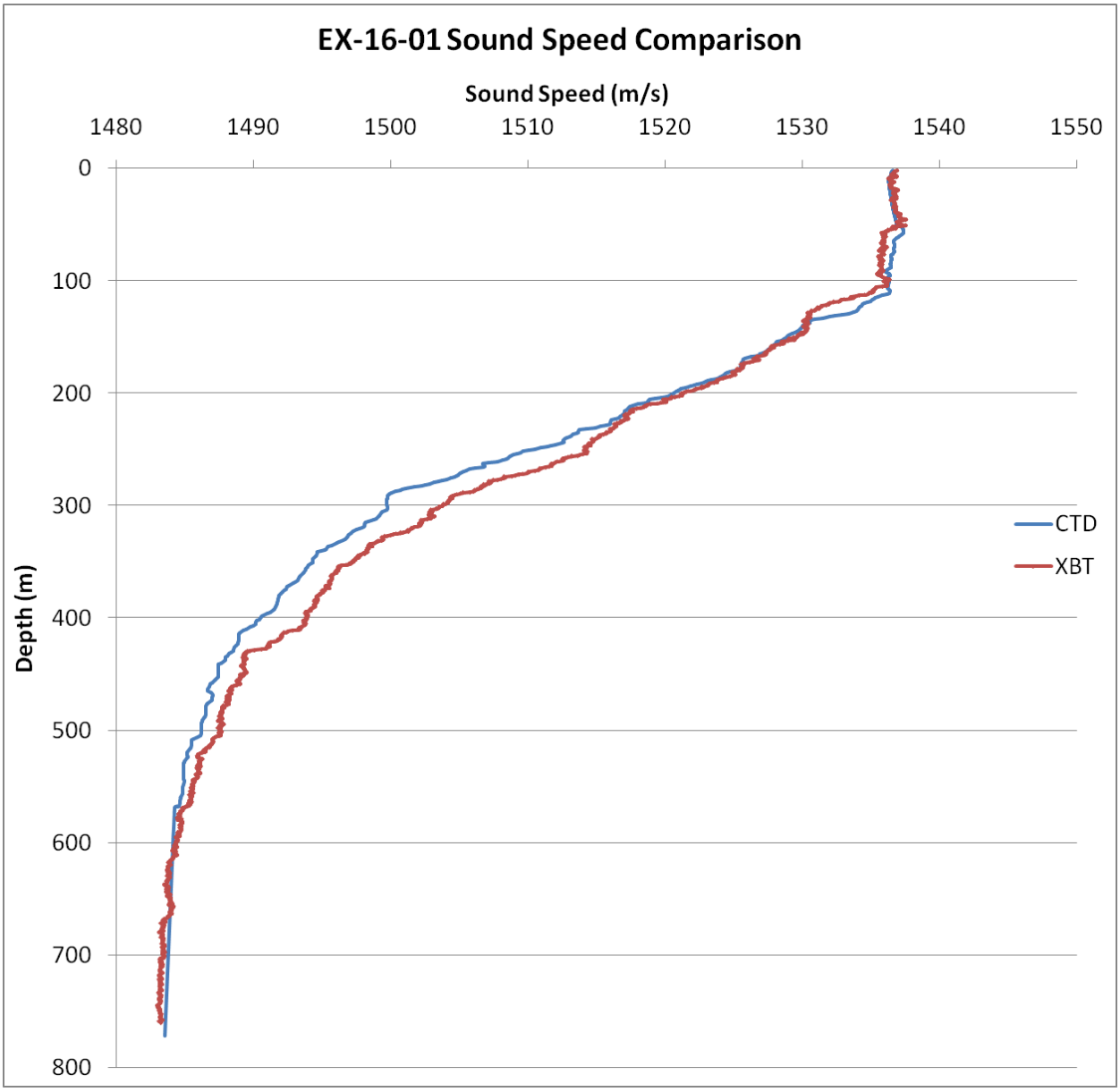
333Khz_Cal.txt
333Khz_SAT_Data-D20160204-T224703.bot/.idx/.raw
333Khz_SAT_Data-D20160204-T230133.bot/.idx/.raw
Effect of Knot.png
Effect of Knot_2.png

Frequency 333 kHz Calibration Attempt 3; Pulse Length 1.024 ms; Power 50 watts

333Khz_Cal.txt
333Khz_SAT_Data-D20160204-T230821.bot/.idx/.raw

Sound Speed Profile Comparison

CTD and XBT casts were conducted in tandem for comparison to ensure the two sound speed profiling systems provide comparable results. The files were EX1601_XBT033_160206.asvp and EX1601_CTD001_160205.asvp.



Surface Sound Speed Comparison

The TSG and Reson SV70 systems were observed to provide comparable results in surface sound speed.

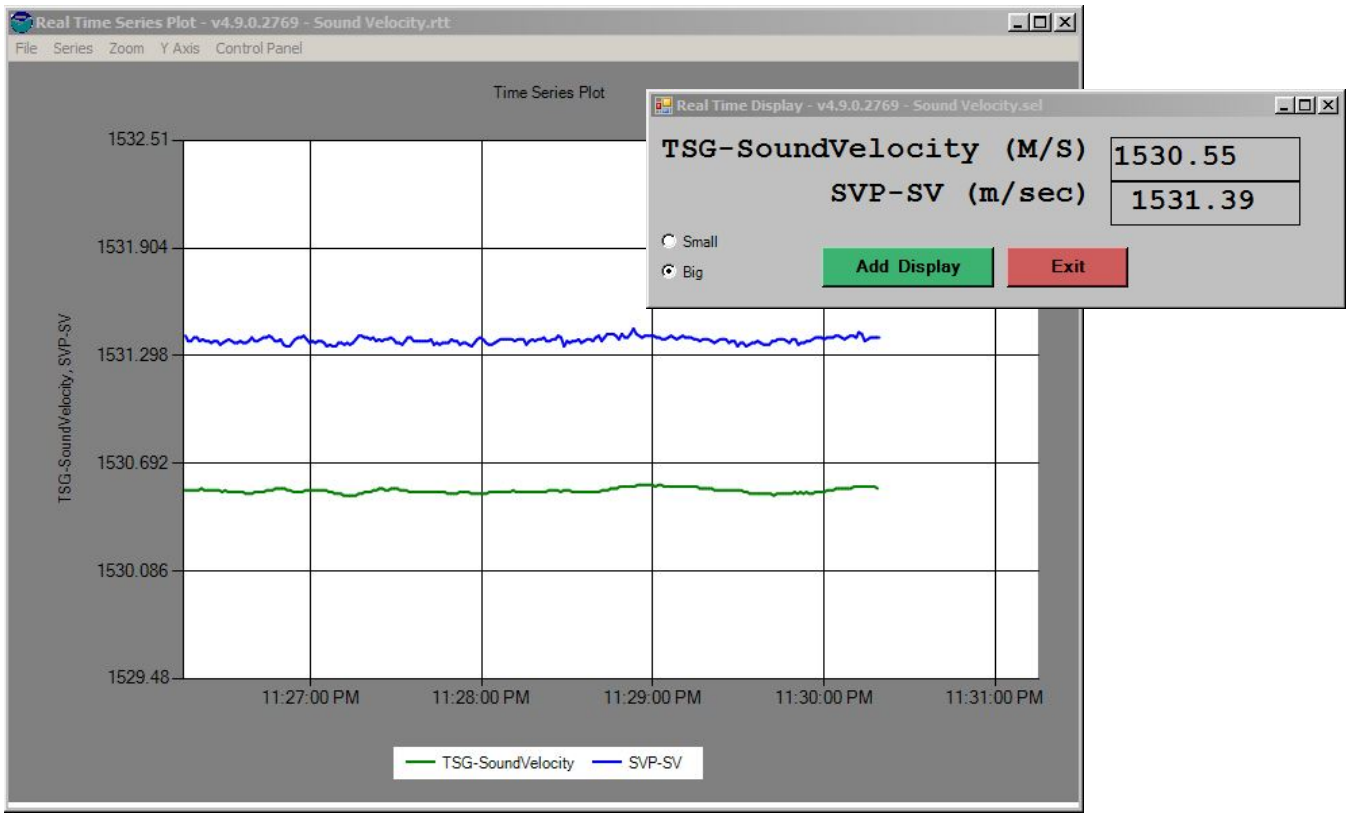


Figure 4. Screenshots from SCS showing comparison between surface sound speed measurements from Reson SVP 70 and TSG.

GAMS Calibration

Figure 5. GAMS calibration results from 20 January 2016.

Data Processing

Detailed standard operating procedures (SOPs) for all data collection and processing routines performed by the mapping team onboard *Okeanos Explorer*. The purpose of this data processing section is to describe the current status of a few data processing pipelines.

Multibeam Bathymetry Data Processing

Raw multibeam bathymetry data files are acquired by SIS, and are imported into CARIS. In CARIS, attitude and navigation data stored in each file re checked, and erroneous soundings are removed

using CARIS Swath Editor and Subset Editor. Once per day, cleaned, gridded bathymetric data are exported to ASCII text files (y,x,z) at 50 or 100 meter cell size in WGS84 datum. The ASCII files are then used to create Fledermaus SD objects. These SD objects re then exported to geotiff and Google Earth KMZ, which re copied to the shoreside FTP on a daily basis for shoreside scientist participation.

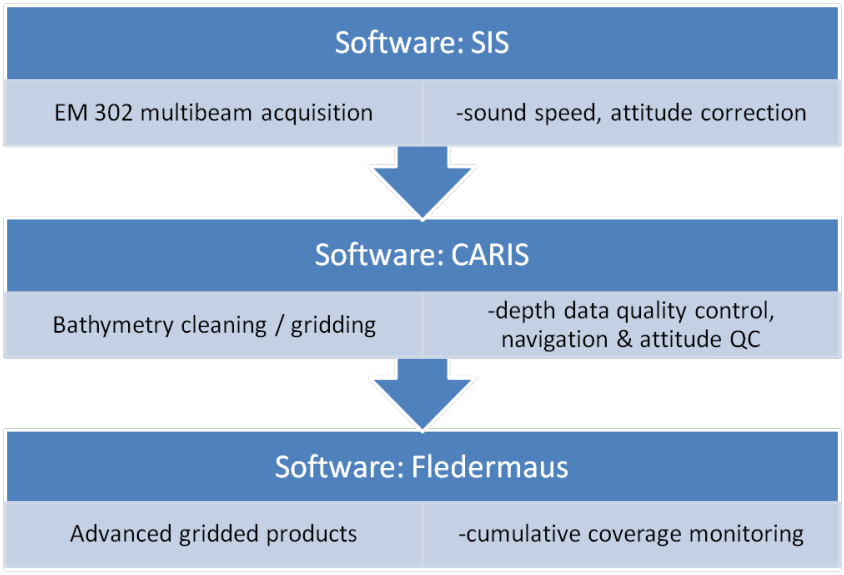


Figure 6. Shipboard multibeam data flow.

As a result of the following, the CARIS vessel configuration file (Okeanos_2016.vcf) for *Okeanos Explorer* contains zeros offsets, and the motion and sound velocity data are not required to be applied during post processing.

- The Kongsberg SIS system accounts for all the static offsets and biases during real time acquisition.
- The motion data from the POS MV is directly fed into SIS during data acquisition to account for ship motion (i.e. heave, roll, pitch) and heading.
- Offsets determined during annual patch testing are applied in realtime with SIS.
- The real-time sound speed near the sonar head is fed into SIS and the most recently acquired sound speed profile is used in real time to correct soundings for sound speed corrections during data acquisition.
- Unless there are problems observed in the data, there is no requirement to apply these corrections during post processing in CARIS.

Multibeam Bottom Backscatter Data Processing

The QPS Fledermaus FM Geocoder Toolbox software package used for processing EM 302 bottom backscatter data. This version of FMGeocoder is installed when as part of the QPS install.

Multibeam Water Column Data Processing

The QPS Fledermaus MidWater software package is used to process EM 302 water column backscatter and EK 60 data and view the resulting Fledermaus SD objects. The output SD objects are viewable via a free software iView4D available here http://www.qps.nl/display/fledermaus/iview. EK 60 Water Column Data Processing

Water column data is reviewed daily throughout cruises to examine for the presence of seeps and other water column anomalies.

ADCP Data Processing

The processing routine for ADCP data is under testing during the 2016 field season.

XBT Data Processing

XBT data is collected using WinMK21 software. Raw XBT data is then converted to .asvp format (required by SIS) using Velocipy, and is then imported into SIS for extension to full ocean depth and realtime application.

CTD Data Processing

CTD data is collected and processed using the standard Sea-Bird software suite. If required for multibeam data sound speed correction, CTD data is converted to .asvp format (required by SIS) using Velocipy, and is then imported into SIS for extension to full ocean depth and realtime application.

Subbottom Data Processing

The freeware SEGYJP2 is available onboard for first order subbottom profile data processing.

Data Management and Archival Procedures

Pursuant to the OER open data policy, all mapping data collected by *Okeanos Explorer* are archived and publically available within 90 days of the end of each cruise via the National Centers for Environmental Information (NCEI) online archives. The 2016 Data Management Plan is available upon request.

A mapping data report is generated for every cruise and is archived alongside the data at NCEI and in the NOAA Central Library. The mapping data report aims to promote understanding of the dataset collected during the cruise to promote ease of use of the data. This Readiness Report is intended to compliment the mapping data reports.

Appendices

Documents Available Upon Request (oar.oer.exmappingteam@noaa.gov)

Calibrations documents are available for the following equipment:

- Reson SVP 70 probes
- CTD sensors

Report of Sonar Systems and GPS Antennae as-builting on the NOAA *Okeanos Explorer*, 2008

Report of Stability Test of NOAA Ship Okeanos Explorer, 2008