Ocean Exploration and Research

MAPPING DATA ACQUISITION SUMMARY REPORT

CRUISE EX-18-99

Post dry dock transit and ADCP acceptance trials

September 12 - September 19, 2018

Norfolk, VA – Davisville, RI

Mashkoor Malik and Charles Wilkins

September 19, 2018

1. Introduction

NOAA Ship Okeanos Explorer was in dry dock from August 1 - Sept 10, 2018. During this time, the EM 302 receive array, ADCP 300 kHz sonar transducer, and EK 60 (18 kHz) sonar transducer were replaced. This expedition is focused on conducting harbor and sea acceptance trials for these replaced sonar systems, calibrating the multibeam sonar and ADCP, and completing shakedown work on ship and mission equipment to ensure the ship is operationally ready. Due to unavailability of technical representative from Kongsberg (sonar manufacturer of EM302, EK60) only ADCP sea acceptance trials were completed during this expedition. EM302 and EK60 remained secured during this cruise.

2. Cruise Objectives

ADCP 300 kHz was replaced by Teledyne during August dry dock. A detailed report of the ADCP replacement is available as Appendix A (Teledyne rep trip report WHMVM300). Sea Acceptance Trials as per instructions from Teledyne were completed during this expedition.

Table 1. Following personnel participated in the cruise in support of mapping operations.

NAME	ROLE	AFFILIATION
CDR Eric Johnson	Commanding Officer	NOAA Corps
LT Rosemary Abbitt	Field Operations Officer	NOAA Corps
Mashkoor Malik	Expedition Coordinator	NOAA OER
Charles Wilkins	Senior Survey Technician	NOAA
Andy O'brien	Network support	GFOE
Andy Lister	Network support	GFOE
Roland Brian	Network support	GFOE

3. Summary of Mapping Results

Teledyne ADCPs

Okeanos Explorer currently has two ADCP data acquisition systems (DAS):

1. Teledyne provided data acquisition system: VmDAS (Vessel Mount Data Acquisition Software) version 1.49.
2. University of HI provided data acquisition system (UHDAS, a linux based system)

These two separate and independent DAS were used for testing of ADCP. University of Hawaii (UH) has an ongoing contract with OMAO to manage the *Okeanos Explorer* ADCP data and is

the default DAS used for regular operations with ability to be monitored and operated remotely. Teledyne, however, has requested to run the acceptance trials using Teledyne DAS. Only details of VmDAS are included in this report.

Data acquisition parameters

Preliminary test plan 300 kHz ADCP based on input from Teledyne rep:

Harbor Acceptance Trial:

The ship came out of dry dock on 10 September 2018. A harbor acceptance trial was completed on 11 September 2018 where the self-checks were run while alongside pier. All tests except PC Card #0 and #1 passed. Teledyne confirmed that these cards are not crucial to ADCP operations.

Table 2. Print out of ADCP self-test.

```
[BREAK Wakeup B]
WorkHorse Mariner ADCP Version 52.41
Teledyne RD Instruments (c) 1996-2014
All Rights Reserved.
>cr1
[Parameters set to FACTORY defaults]
>ck
[Parameters saved as USER defaults]
>pa

PRE-DEPLOYMENT TESTS

CPU TESTS:
  RTC.....PASS
  RAM.....PASS
  ROM.....PASS
RECORDER TESTS:
  PC Card #0.....NOT DETECTED
  PC Card #1.....NOT DETECTED
DSP TESTS:
  Timing RAM.....PASS
  Demod  RAM.....PASS
  Demod  REG.....PASS
  FIFOs.....PASS
SYSTEM TESTS:
  XILINX Interrupts... IRQ3  IRQ3  IRQ3 ...PASS
  Wide Bandwidth.....PASS
  Narrow Bandwidth.....PASS
  RSSI Filter.....PASS
  Transmit.....PASS
SENSOR TESTS:
  H/W Operation.....PASS
```

```
>pt3

Correlation Magnitude: Wide Bandwidth

          Lag  Bm1  Bm2  Bm3  Bm4
            0  255  255  255  255
            1  166  168  171  169
            2   21   25   33   28
            3   13   10    3   11
            4   18   15   15   14
            5   12   14   11   12
            6    2    5    2    1
            7    6    4    2    8

  High Gain RSSI:    32   36   37   34
   Low Gain RSSI:     5   10   10    7

  SIN Duty Cycle:    50   51   49   50
  COS Duty Cycle:    50   48   49   50

Receive Test Results = $00000000 ... PASS
>pt6
Receive Bandwidth:
    Sample     bw    bw    bw    bw    bw
      rate  expect   Bm1   Bm2   Bm3   Bm4
       307     120   108   106   106   105 Khz
   results          PASS  PASS  PASS  PASS
```

Sea Acceptance Trials

Sea acceptance trials consisted of running the following three tests. For each test VmDAS generated these file types: *.ENR, *.ENS, *.ENX, *.LOG, *.LTA, *.N1R, *.NMS, *.STA, and *.VMO. These files were shared with Teledyne and UH.

1) **Transducer alignment** ; Bottom track should be ON

a) Hold course for 45 minutes
b) Slow, smooth turn ~20 minutes
c) Run reciprocal line over same course
d) Slow, smooth turn ~20 minutes
e) Run reciprocal line over same course preferred,

Both Teledyne and UH processed the data and came to same alignment angle of 45.63 deg. for the transducer offset. The transducer offset angle was put in UHDAS by UH (Jules Hummon). The offset angle was not put in VmDAS. for the final command setup, the command file needs to have EA command with the new offset added. In future if VmDAS is needed to be run this angular offset will need to be included in the command file: See example below.

```
; Output beam data (rotations are done in software)
EX00000

;Set Transducer Alignment offset (hundredths of degrees)
EA04563

; Set magnetic compass offset or compass bias offset (hundredths of degrees)
EB00000

; Set transducer depth (decimeters)
ED00000
```

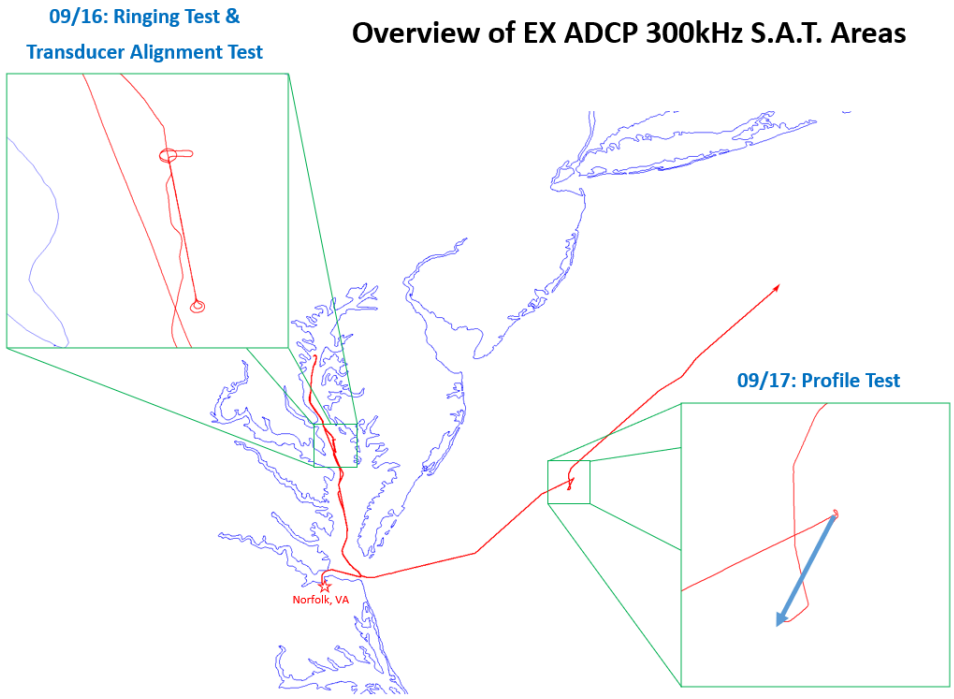


Figure 1. Plot of ship track showing locations of ADCP trials.

2) Ringing test (Bottom tracking ON)
Hold course at normal survey speed for 1 hour.

3) Profile test (deep water required for usable data, minimum depth for usable data =300m) (Bottom tracking should be OFF)
Collected data for 15 minutes at speeds of; drift, 3, 6, and 9 (maximum speed).
The data collected during profile tests were shared with Teledyne representative on shore who provided the following estimates of ranges:

Table 3. Speed vs. profile range.

Speed	Profile Range (m)
Drifting	130 m
3 Kts	127 m
6 Kts	110 m
Max	105 m

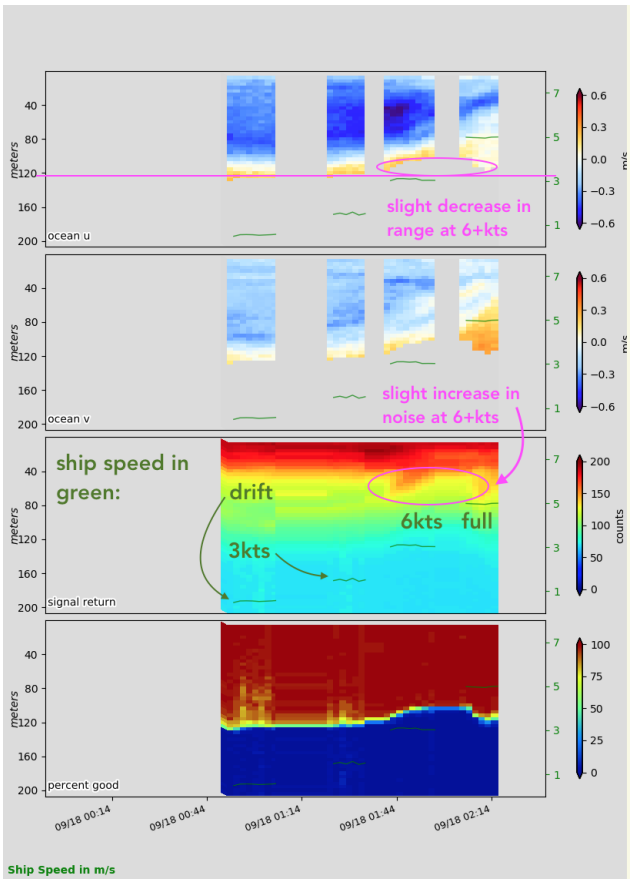


Figure 2. Image showing the range vs. speed comparison. Image courtesy Jules Hummon (UH/NOAA)

Table 4. ADCP field testing notes and weather conditions.

EX ADCP 300kHz SAT Field Notes	
All times are UTC	
9/16/2018	
VMDAS Ringing Test **Filename: EX ADCP 300 Ringing Test_20180916T171502_010_000000**	
2115	**Begin Ringing Test**
	Speed 6.2 kts
	Heading 171 deg.
2215	**End Ringing Test**
VMDAS Transducer Alignment Test **Filename: EX ADCP 300 Transducer AlignmentTest_20180916T182719_010_000000**	
2225	**Begin Line 1**
	Speed 6.5 kts

	Heading 358 deg.	
2322	**End Line 1**	**Begin Turn**
2343	**End Turn**	**Begin Line 2**
	Speed 6.4 kts	
	Heading 171 deg.	
0034	**Halt Test line for unexpected Bridge / Deck ops.**	
0038	**End Line 2**	**Begin Turn**
0054	**End Turn**	**Begin Line 3**
	Speed 6.4 kts	
	Heading 355 deg.	
0150	**End Line 3**	
0150	**End Test**	
UHDAS Transducer Alignment Test		
0200	**Begin UHDAS Acquisition**	
09/17/2018		
VMDAS Profile Test **Filename: EX ADCP 300 Transducer Profile Test_20180917T212002_010_000000**		
0047	**Begin Drift Test**	
	Wave	2-3 ft
	Swell	3.5 ft
	Swell Dir.	140 deg
	Wind Speed	22 kts
	Wind Dir.	180 deg
0105	**End Drift Test**	
0119	**Begin 3kts Test**	
	Wave	2-3 ft
	Swell	3.5 ft
	Swell Dir.	140 deg
	Wind Speed	18 kts
	Wind Dir.	168 deg
0134	**End 3kts Test**	
0138	**Begin 6kts Test**	
	Wave	2-3 ft
	Swell	3.5 ft
	Swell Dir.	140 deg
	Wind Speed	20 kts
	Wind Dir.	169 deg
0156	**End 6kts Test**	
0201	**Begin Max Speed Test**	
	Wave	2-3 ft
	Swell	3.5 ft
	Swell Dir.	140 deg

	Wind Speed	23.5 kts
	Wind Dir.	170 deg
0217	**End Max Speed Test**	

GAMS Calibration

The GAMS calibration was conducted between 1800-2030 on 18 September 2018 (EDT). This calibration followed the GAMS SOP. A heading threshold of 1 degree was used while running GAMS calibration. On a steady course 15 minutes of data were logged before commencing GAMS calibration. After zeroing of the GAMS parameters, the ship conducted tight figure of 8 turns to lower the estimated heading accuracy. Once the heading accuracy was lower than 1 degree and have been stabilized, the GAMS calibration was manually started. Three runs of the GAMS calibration were completed.

Following figure shows the pre- GAMS solution along with the three runs of GAMS solutions. The X component shows the largest change in this lever arm, according to the GAMS result. Comparing the results from different runs, it appears the GAMS results varied up to 22 mm (compare 22 mm, 31 mm and 9 mm offset obtained for x-components in three runs). At the very least, it confirms that no major modification was made unintentionally to the antenna position during dry dock. However, large differences between the three runs need further investigation. The values from the latest land survey (NGS, 2015) were put in as GAMS parameters. Heading accuracy stabilized to 0.026 degrees a short time after putting the GAMS parameters based on land survey.

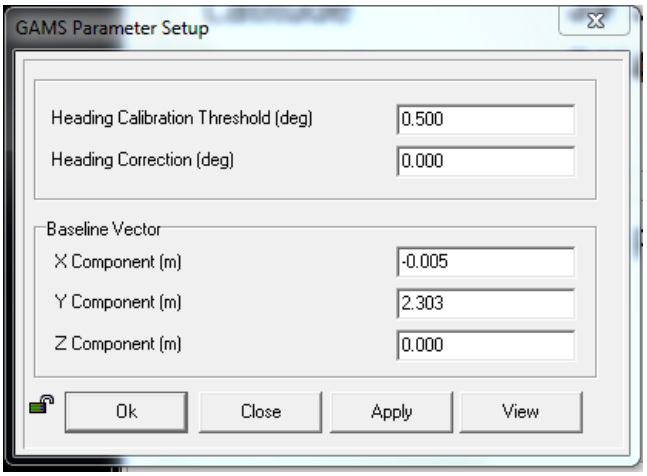


Figure 3. GAMS solution prior to GAMS calibration.

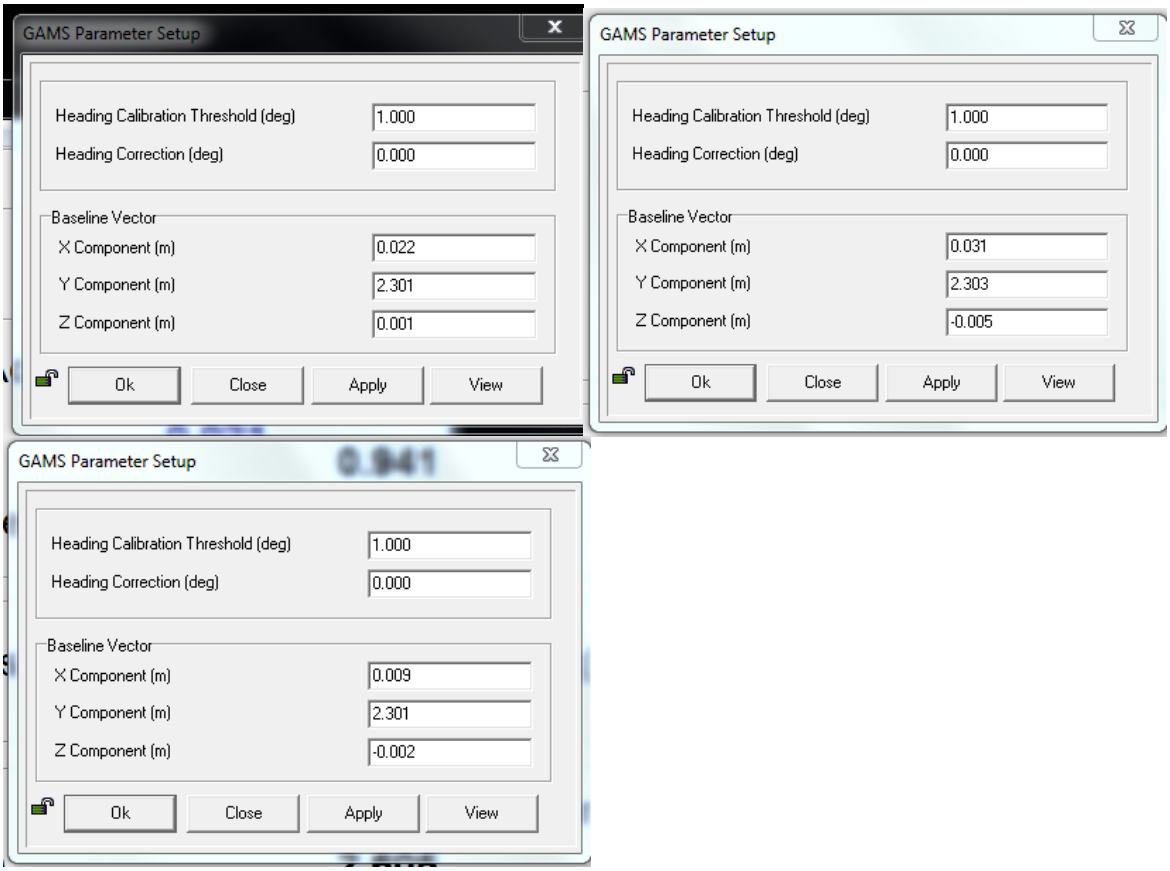


Figure 4. GAMS solution obtained from three runs of GAMS calibration.

The land survey conducted in 2015 (NGS, 2015) showed the following values for the base line vector:

Table 5. POS MV antennas baseline vector compute from land survey (NGS, 2015). The baseline vector is computed with STBD antenna as a reference.

Baseline vector	Land survey value
X	0.007 m
Y	2.302 m
Z	0.013 m

3. Mapping Statistics

No mapping data except for ADCP testing data collected during this expedition.

4. Mapping Sonar Setup

UHDAS runs on a Linux machine while VmDAS was setup temporarily on the Science Client 1 machine for this cruise. The switch over between the two machine was completed by swapping the USB cable from the 8 port serial box.

Figure 5. 8 port serial box behind the UHDAS machine

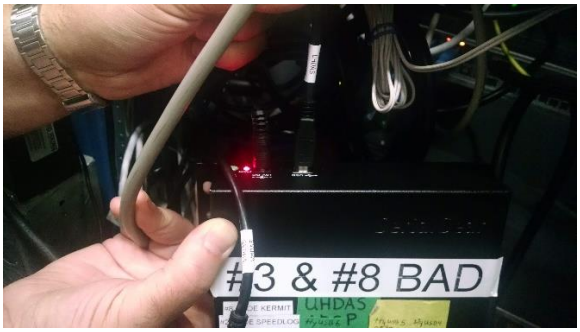
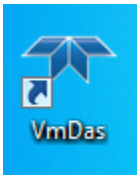


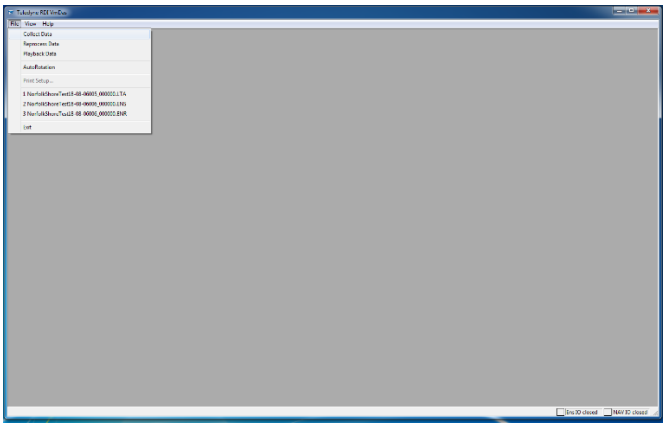
Figure 6. UHDAS cable connected to serial cable box

Figure 7. VMDAS cable connected to serial box

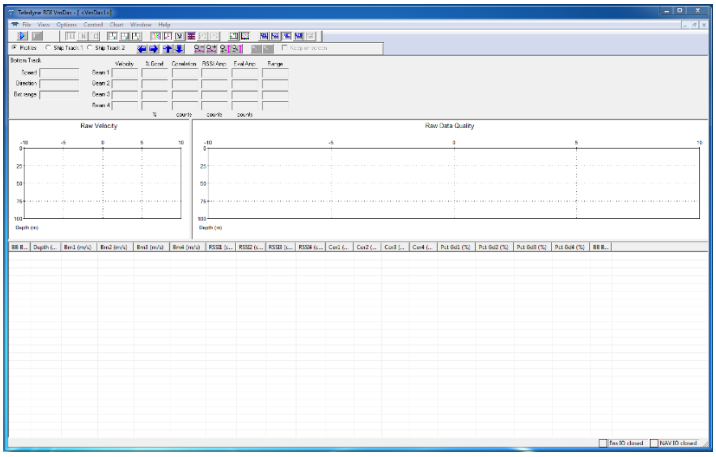
Instructions for running VmDAS



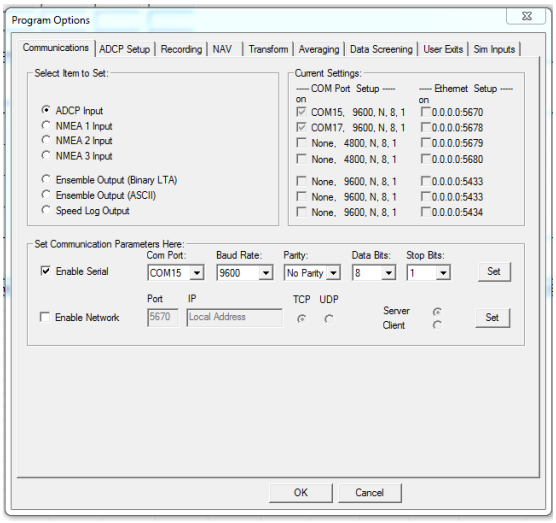
Run VmDAS by selecting the VmDAS from desktop



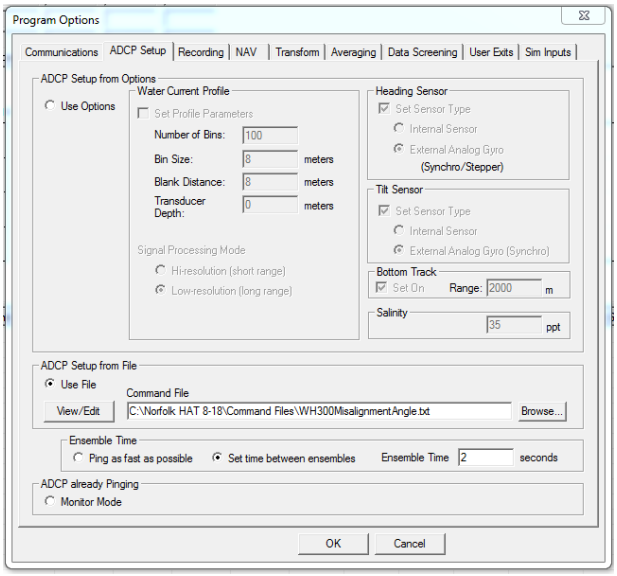
Select collect data from File drop down menu



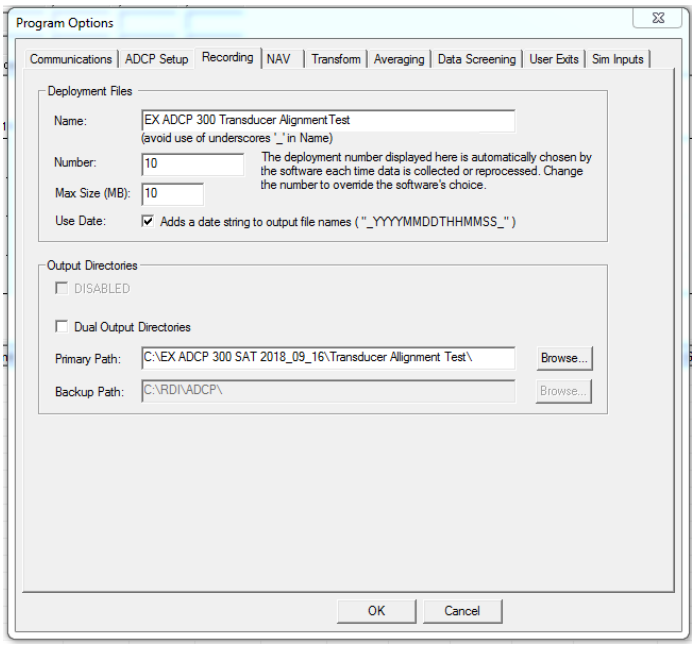
The main interface for VmDAS



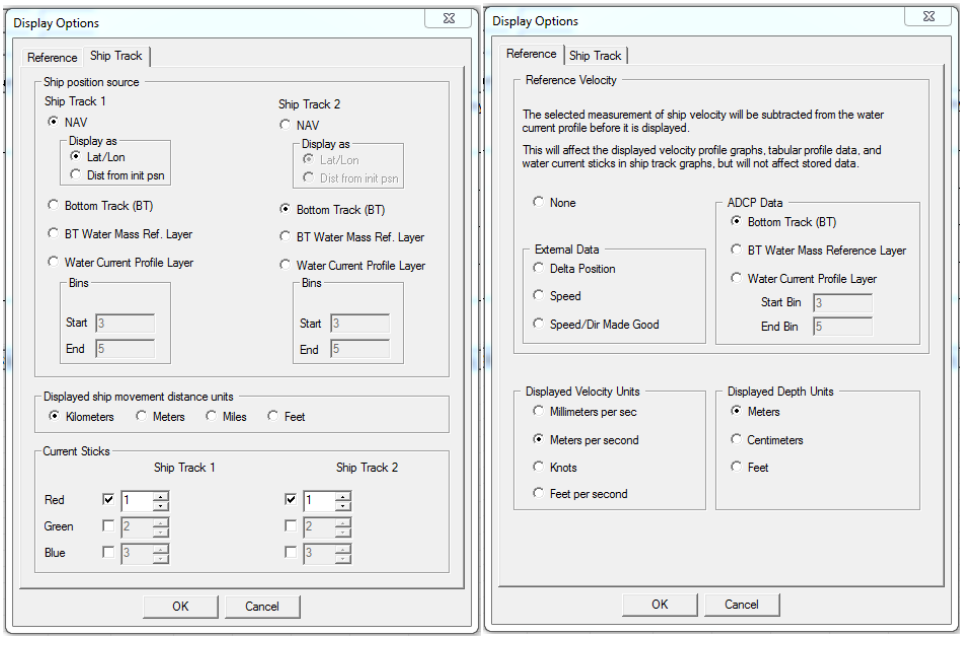
Various settings for VmDAS can be accessed through program options



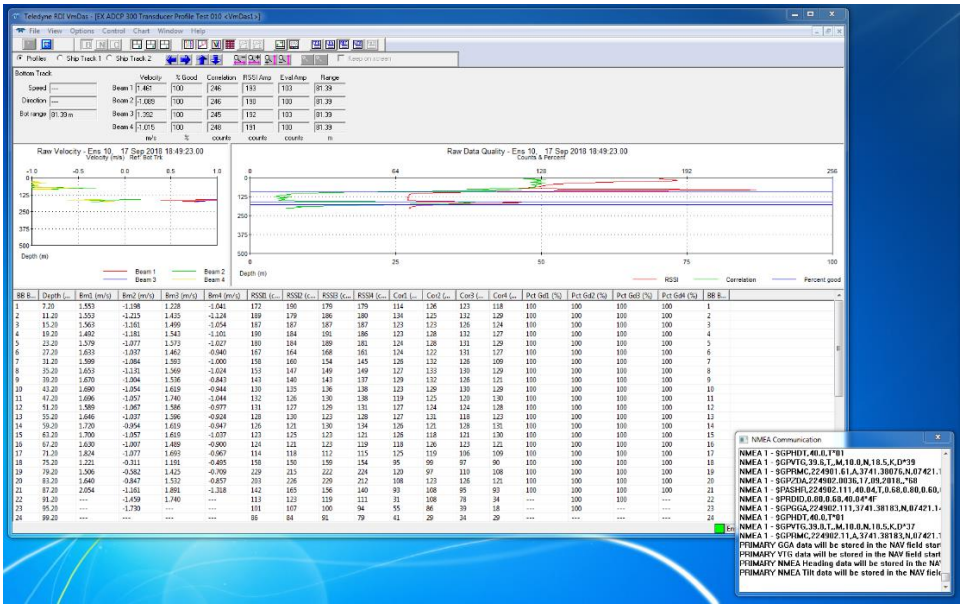
WH300MisalignmentAngle.txt setup file was used during the data acquisition



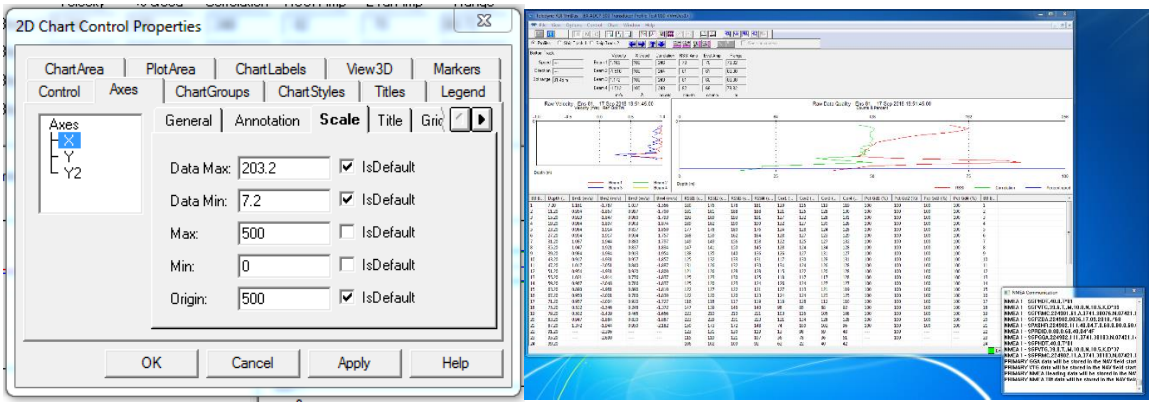
The data were recorded locally on VmDAS machine.



Bottom track can be turned on through display options.



VmDAS display while collecting data.



The chart axis can be controlled through 2D chart control properties.

5. Data Archival Procedures

This is a shake down / sonar acceptance cruise. Decision for data archival and report generation will depend on the quality and type of test data. Archival of cruise data will be decided in consultation with NCEI after the completion of cruise.

6. Cruise Calendar

September 2018						
Sun	Mon	Tues	Wed	Thur	Fri	Sat
	9/10 Ship refloating Depart dry dock	9/11 Fueling	9/12 Depart Norfolk	9/13 Shelter in Chesapeake Bay	9/14 Shelter in Chesapeake Bay	9/15 Shelter in Chesapeake Bay
9/16 Small boat personnel transfer. Commence transit to RI. ADCP shallow water trials	9/17 Continue transit to RI. Deep water ADCP trials.	9/18 Continue transit to RI. GAMS calibration.	9/19 Arrive Davisville, RI			

7. Daily Cruise Log Entries

Generated from the daily expedition situation reports. All times listed are in local ship time (+13 hours from UTC)

9/12-9/15

No update. Ship sheltering in northern Chesapeake Bay due to Hurricane Florence.

9/16/2018

Three personnel were transferred via small boat from Annapolis, MD. ADCPs were turned on while leaving harbor and were kept on with bottom tracking (for the purposes of calibration). The data will be examined by UH. Further tests may need to be run for ADCP. Shallow water transducer alignment test was completed using VmDAS.

9/17/2018

Deep water ADCP profile test at different speeds in water depth of 300 m was completed using VmDAS.

9/18/2018

In transit to Davisville, RI. Conduct GAMS calibration.

9/19/2018

Continued transit to Davisville, RI. Arrived at Davisville, RI ~ 1000 (EDT). Secured all sonars.

8. References

1) EX-18-99 Project Instructions can be obtained by contacting NOAA Ship *Okeanos Explorer* at ops.explorer@noaa.gov.
2) NGS, 2 January 2015, POS MV Antennas survey report prepared by Kevin Jordan. Available onboard or by request from ops.explorer@noaa.gov.

Appendix A: Teledyne Service Report

Trip Report: NOAA R/V Okeanos Explorer

Dates of Service: August 2nd to August 7th 2018.

Customer Contact: Kenneth Nadeau

TRDI Representative: Tony Phakonekham, Field Service Engineer

Reason for Visit: Supervision/Installation/Cable Termination/Sea Trial

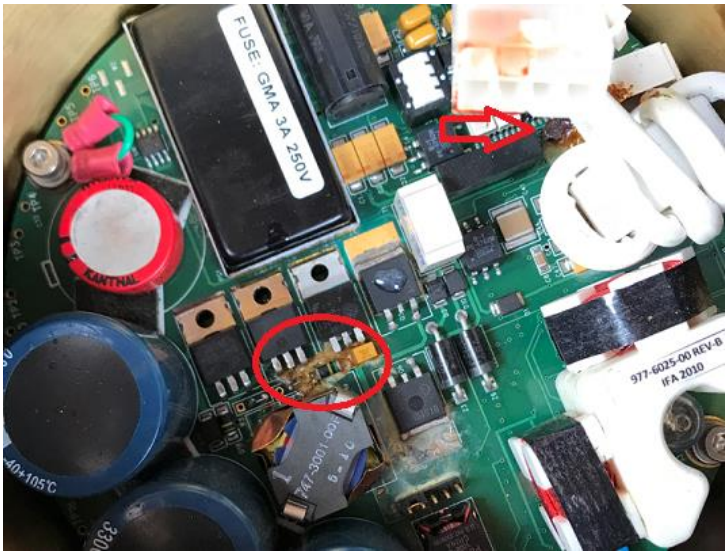
Summary of Events: Preparing and testing Mariner300 after installation onto the vessel.

August 2nd, arrived at Colonna's shipyard Norfolk, VA to supervise transducer installation, perform cable termination and inspection Mariner300. Met with Ken Nadeau and the rest of the crews to plan the work of ADCP.

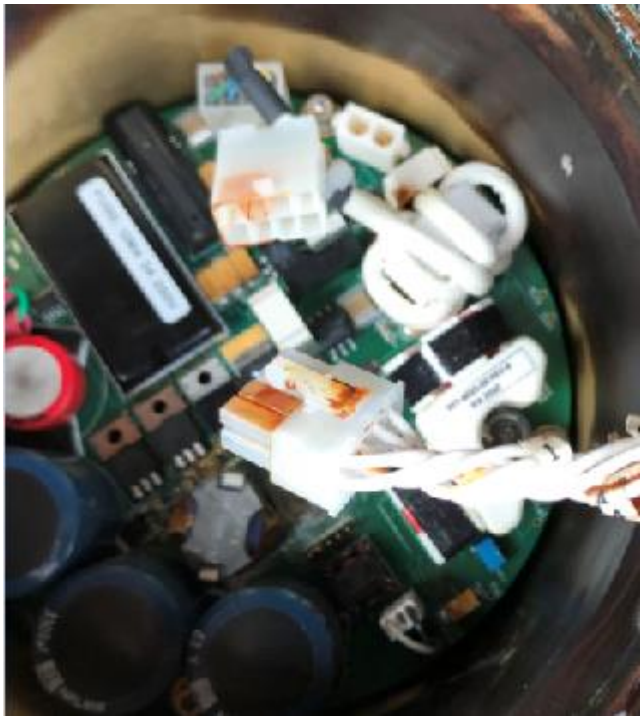
Vessel (Okeanos Explorer) found in dry dock. While waiting for transducer and cable to be removed/installed/pulled, tested the new transducer serial number 24600 with the help of Mike Peperato with two deck boxes; one from Okeanos the other was a loaner from University of Hawaii. Dedicated deck box and new transducer functioned as expected. Loaner did not work.

Performed failure analysis on WHMVM300-I-CUSTOM serial number 14608 after it was removed from the transducer well by electrician; transducer was flooded. See pictures below for more details. It appeared that the ingress of water/moisture through connector.

Damaged PIO board.



Wiring cable from the end cap, this is very likely the ingress of moisture/water path.



Per Ken Nadeau, checked wet-end transducer cable of OS38; found corrosion on multiple pins. O-Ring (2-022) was intact. See pictures below.

Cable resistance on D-C is at 22Ω, shorted.

Notes:

Trasnducer installation and cable pulling was performed by shipyard; was there to supervise only and did not participate is the actual installation and cable pulling.

Day 1. Waiting for shipyard crew for clean out of transducer well/blister on the vessel.

Day 2. Crew finished clean out, diconnected and inspected transducer cable on WHMVM300kHz-CUSTOM and OS38.

Day 3. Supervised the removal of WHMVM300kHz CUSTOM transducer. Waited for electrician to remove old transducer cable. It appeared that one of the gland nuts had been damaged during the removal.

Day 4. Supervised/guided transducer installation.

Day 5. Standby at the shipyard.

Day6. Tested WHMVM300-I-CUSTOM after electrician temporarily pulled the new transducer cable. ADCP functioned as expected.

Attachments: U:\RDI\CustService\CUSTSVS\FieldService\Trip Reports\Trip Data\180801_RV_OKEANOS_EXPLORER_Norfolk_VA