

Healy 2012 ADCP Evaluation

Dr. Julia M. Hummon
University of Hawaii hummon@hawaii.edu

October 2, 2012

Contents

1	Introduction	2
2	ADCP Evaluation	3
2.1	Healthy Data Sample – HLY1102	4
2.2	2012 Sea Trials – HLY12TA, HLY12TB	7
2.2.1	Data Collection	7
2.2.2	Background noise and range	7
2.2.3	Bias	12
3	UHDAS Software Installation	13
3.1	Computer	13
3.2	Serial Ports	13
3.3	UHDAS and CODAS settings	14
3.4	UHDAS (CODAS) data processing organization	15
A	Appendix: Cruise Settings	16
A.1	HLY12TA Settings	16
A.1.1	Cruise segments (time ranges)	16
A.1.2	Processing parameters	16
A.1.3	Acquisition parameters (time ranges)	16
A.1.4	Acquisition parameters (configuration chunks)	17
A.1.5	Power source (by file)	18
A.2	HLY12TB Settings	19
A.2.1	Cruise segments (start times)	19
A.2.2	Processing parameters	20
A.2.3	Acquisition parameters	20
A.2.4	Power source (by file)	20

B Appendix: HLY12TB grooms	22
B.1 OS150 groom	22
B.2 HLY12TB OS75 groom	24
C Appendix: Installation Photos	25

1 Introduction

USCGC Healy presently has two Doppler current profilers made by Teledyne RDI. Both are the Ocean Surveyor model, which uses a single phased-array transducer to generate all four acoustic beams. The two instruments differ in their operating frequency, nominally 75 kHz (OS75) and 150 kHz (OS150). The lower frequency allows profiling at greater range, but with reduced resolution, compared to the higher frequency.

Prior to 2010, ADCP data acquisition was performed by the manufacturer’s software, Vm-DAS. In 2010, a new system UHDAS, developed at the University of Hawaii, was installed for ADCP data acquisition and processing.

Major changes in the ADCP system have occurred prior to each of the last three field seasons. In 2010, UHDAS was installed, and ran without incident during the 2010 field season, though ADCP ranges were poor. In 2011, the ADCP deck units were moved to a temporary location to try and improve range and decrease bias by getting the deck units and transducer cables away from sources of electrical interference. The 2011 field season saw dramatically improved range. Prior to the 2012 field season, the deck units were moved to a new permanent location. Evaluation was attempted during two cruises prior to the 2012 season: Sea Trials (HLY12TA), which occurred before the installation was complete, and the transit to Dutch Harbor for the first cruise, which occurred after the deck units were permanently installed in their final location. Although poor range was found, neither one of these cruises afforded good opportunity to diagnose and troubleshoot the problem. Adequate diagnosis and testing are impossible if there is insufficient time with control over the ship’s speed and direction.

At the start of the 2012 season, ADCP ranges were as bad as they were in 2010: so unfortunately, there is still a problem. An attempt will be made to isolate the OS75 deck unit from IC/Gyro power and the system will be evaluated using data from the remainder of the 2012 season. This report summarizes the evaluation of ADCP quality prior to the 2012 field

draft 1 (2012-05-12)
draft 2 (2012-09-06)
final (2012-10-02)

season and the UHDAS software update that occurred in preparation for this year's field season. Settings used for the evaluations are included.

2 ADCP Evaluation

The ADCP deck units were housed in IC-GYRO for many years. The quality of the ADCP data was known to suffer from electro-magnetic interference (EMI). This has been a continuing battle.

Three different configurations of power source, deck unit location, and ADCP cable run have been used during 2011 and 2012. Only one long-term configuration (2011) was a dramatic improvement. It is clear that the exact constellation of these components is important to the quality of the data.

2010 Field Season Summary: During the winter inport period of 2010, the 150kHz Broadband ADCP was replaced with a 150kHz phased array Ocean Surveyor (loaned by Univ Alaska, Fairbanks). Also during the in-port period, a new cableway was built from the transducer void to the Potable water room. The OS150 cable was routed through that new cableway in an attempt to reduce electrical noise. The cableway helped, but biases and poor range persisted.

2011 Field Season Summary: During the 2011 season, the deck units were temporarily relocated to a set of shelves in the aft, port corner of the MICA room. The combination of deck unit location, transducer cable run, and power source reduced electrical noise and improved range considerably. Broadband mode of the OS150 was still corrupted by bias. Broadband mode of the OS75 was also biased, but the effect was more subtle.

2012 Pre-Season Summary: During the winter inport period, a permanent location was found for the ADCP deck units (on the aft bulhead of MICA, starboard side). At the time of the HLY12TA science sea trials cruise, the deck units were still in a small rack, strapped to the shelving. The ADCP deck units were not yet on a UPS, so they ran on ship's power on a cable that was provided by the ship, running from IC-GYRO. The final welding and appearance of the UPSs occurred prior to departure for the 2012 field season.

The data from the Sea Trials were very disappointing at the start, with a high noise floor, strong biases, and very poor range. When the source of the AC power was changed to come from the same feed used during the 2011 field season the data quality improved dramatically, to their 2011 quality.

A second evaluation took place during the transit to Dutch Harbor (HLY12TB) to assess the quality of the data when the deck units and power were in their final configuration. Unfortunately, during the transit to Dutch Harbor, the ADCP data were noisy again. Various power configuration tests were performed to try and improve the situation, but none of the tests improved the noise levels.

2.1 Healthy Data Sample – HLY1102

During the preseason ADCP evaluation, noise levels for OS75 were speed dependent, but mostly below 40 counts; OS150 noise levels were not speed-dependent, and mostly below 35. Noise levels were low at all ship speeds.

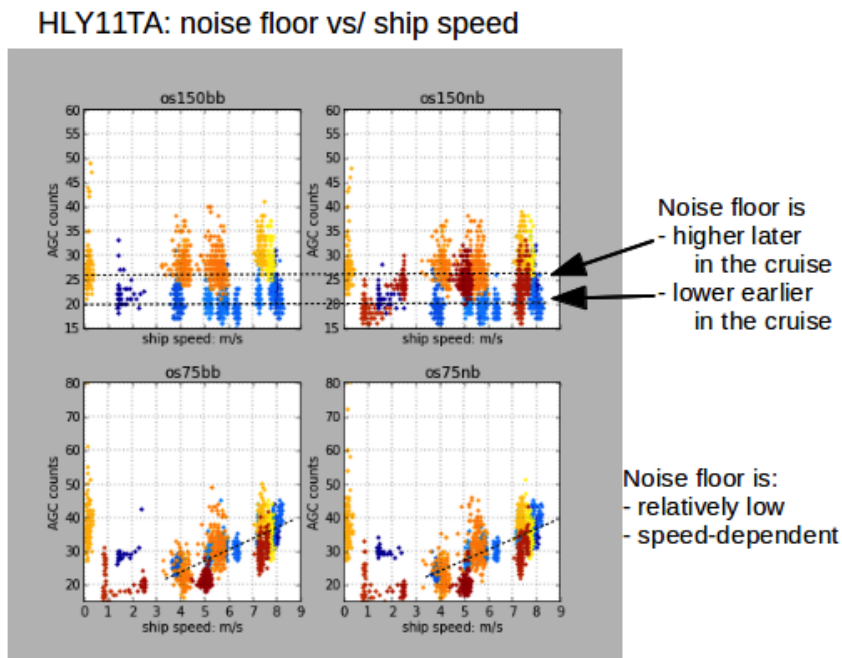


Figure 1: *HLY11TA (Sea Trials prior to 2011 field season): OS150 always quiet; OS75 also quiet, but noise is speed-dependent. Compare with Figure 4, HLY12TB*

Quieter background noise means greater range. HLY1102 was a multibeam mapping cruise and spent some time around 72N, 144W, mapping topography in the Beaufort Sea. Because of the increased range during this season, it was possible to see small (20-30km radius) active (0.2m/s) subsurface eddies at 200-300m and 300-500m. Postprocessing of the at-sea data involved removal of ice-contaminated portions, and application of a scale factor for each dataset: 0.998 (os75nb), 1.003 (os150nb). These data are available at the JASADCP (Joint Archive for Shipboard ADCP) at <http://ilikai.soest.hawaii.edu/sadcp>.

Healy HLY1102 Beaufort Sea Eddies (OS75NB)

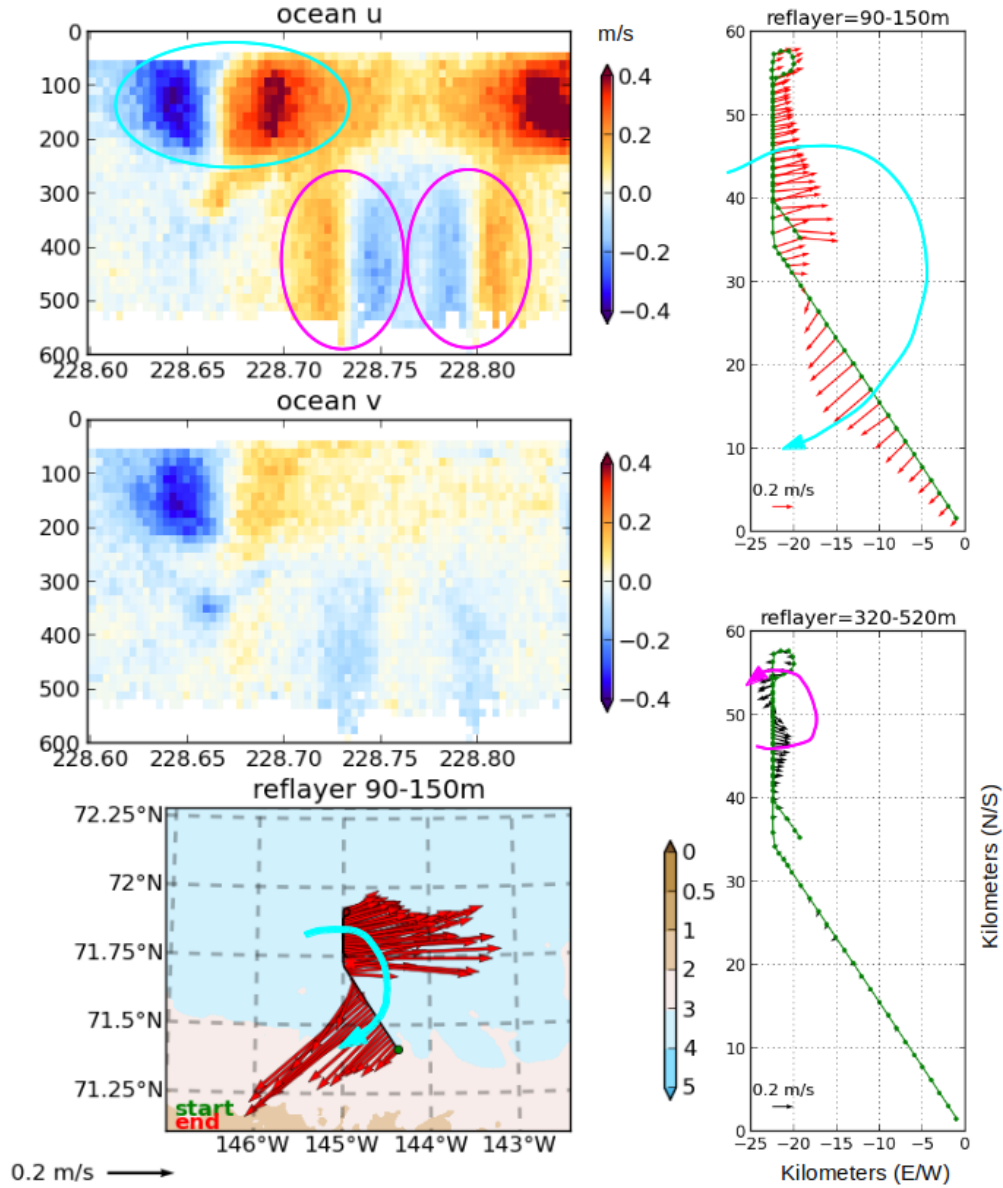


Figure 2: Two eddies have different diameters, speeds, rotational direction, and vertical extent. The shallow clockwise eddy (upper 200m) has a 60km diameter and peak speeds of 0.5m/s, the deeper (300-500m) clockwise eddy is centered at a different location, with a diameter of 15-20km and peak speeds of 0.2m/s.

Healy HLY1102 Beaufort Sea Eddies (OS75NB)

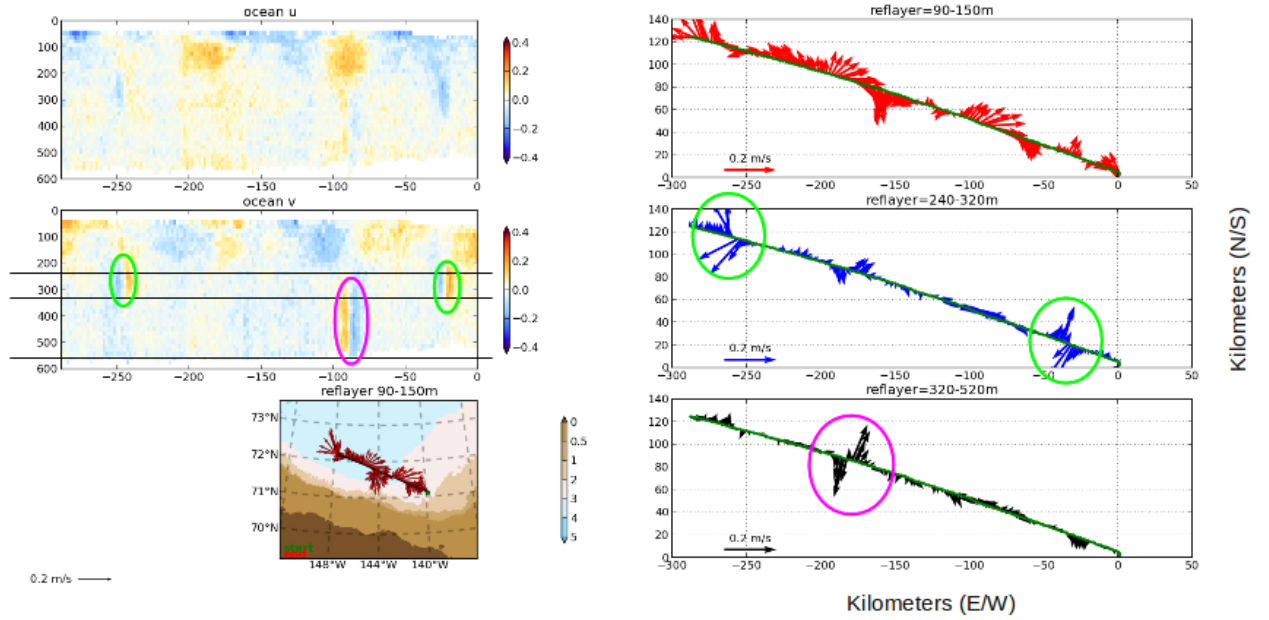


Figure 3: *Eddies are seen below the pycnocline in two subsurface layers. These eddies have peak speeds of about 0.2m/s and diameters of 25-30km. The shallower eddies (200-300m) are rotating opposite to the deeper one (300-500m) in this section.*

2.2 2012 Sea Trials – HLY12TA, HLY12TB

2.2.1 Data Collection

A new location aft starboard MICA) was chosen as the permanent location for the deck units and UPS. The temporary and permanent locations were similar in that they were both as far aft in MICA as was possible, shortening the transducer cable run, and each was on the outside of the ship (away from the power lines in the center).

The ship sailed June 6, 2012, with UHDAS data collection commencing at 18:00 UTC. During the transit west to the test site, data were collected using interleaved broadband and narrowband pinging for each instruments to see whether BB mode was still biased. The BB and NB data ensembles are processed and evaluated independently. Transducer alignment did not physically changed since the previous year, and calibrations show that the values used for processing (which incorporate POSMV alignment) remain valid.

After the first reciprocal track (at 2000m depth) data were compared to 2011 HLY11TA (same region, same season). It was obvious that the OS75 in particular was very noisy and suffered from decreased range. Because the double-conversion UPS was not available, we were running the deck units on ship's power, using a feed provided by the ship, coming from IC-GYRO. When we switched to the power source in aft MICA, 2-37-1 (using the same orange extension cord that was used in 2011) range was dramatically improved, and biases were reduced. Clearly the power source had a great impact on the noise level (and hence range) of the instruments.

The official Sea Trial (HLY12TA) was in June. During July, the temporary installation was made permanent: a mini-tower rack was welded to a location in starboard aft MICA, the deck units and new double-conversion UPS units were installed in the new rack, with the IC-GYRO power supplying the UPSs. Fiber communications were run, and the temperature sensor was hooked up. The goal was a permanent installation that had the same good characteristics as the 2011 season had.

The ship sailed July 30, 2012, with UHDAS data collection commencing around 20:00 UTC. The ship did some training exercises in Puget sound, but for most of the cruise went 15kts-16kts straight to Dutch Harbor. Testing was limited to one short reciprocal track and several periods with slower speed. These were used to try and test speed/noise/range correlations and any biases that were present.

2.2.2 Background noise and range

Data from HLY12TB suffered from high background noise, comparable to the early part of HLY12TA, when power was coming from the IC-GYRO feed. Some brief periods with slower speed showed that the background noise was strongly dependent on ship's speed.

HLY12TB: noise floor vs/ ship speed

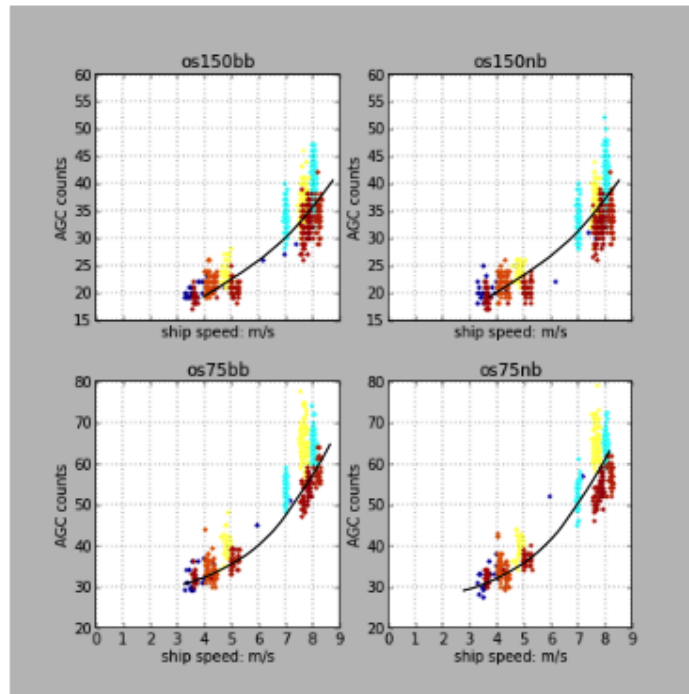


Figure 4: *HLY12TB* (final location, permanent installation): *OS150* (top) and *OS75* (bottom) both have strong correlation of background noise with higher ship speeds. Implications: reduced range when underway. Compare with Figure 1, *HLY11TA*

The next figure shows:

- left panel: low background noise levels for HLY11TA
- center panel: dramatic difference in background noise levels for two power sources
- right panel: return to high noise levels (slight decrease during the cruise is visible)

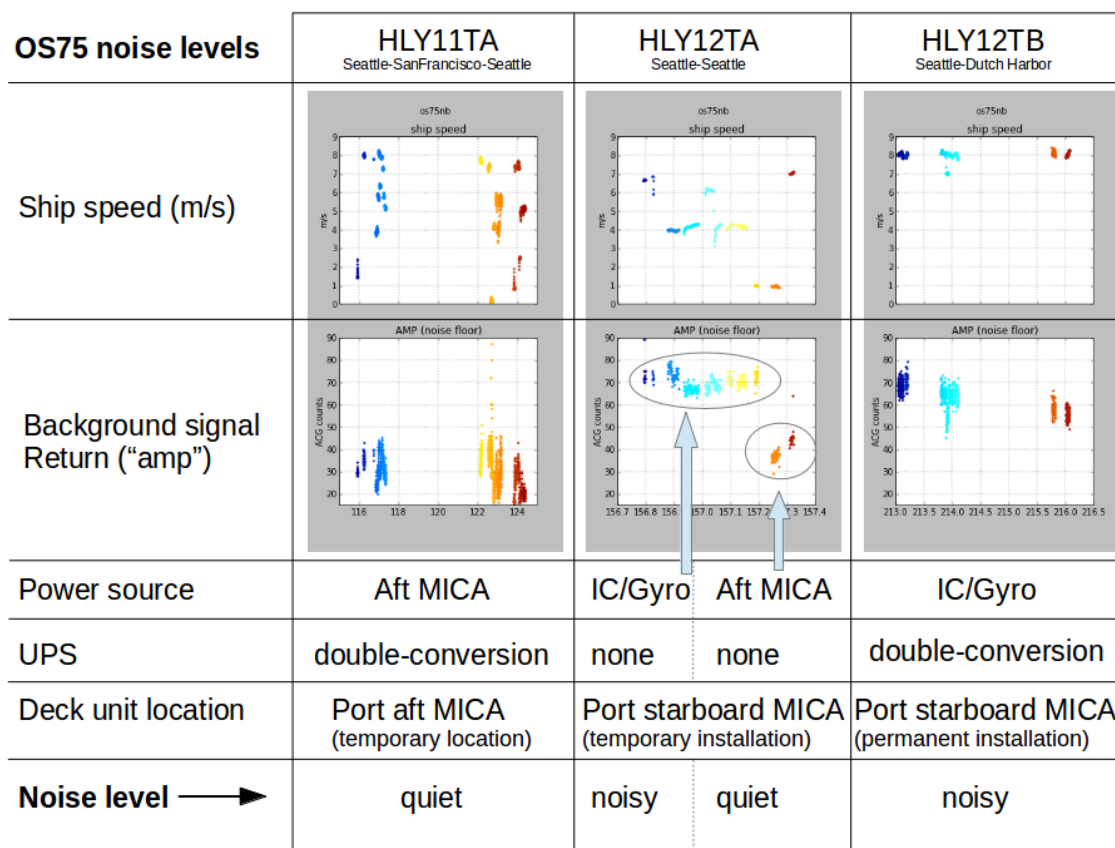


Figure 5: OS75: Summary of background noise between 2011 and 2012 Science Sea Trials. Noise levels for OS150 and OS75 followed a similar pattern: levels were low during HLY11TA and for the entire season, levels were high at the start of HLY12TA but decreased when the power source was changed from IC-GYRO to aft Mica 2-23-1, and high again during HLY12TB.

A dramatic increase in range was seen in HLY12TA when AC power came from an outlet in aft MICA (labeled 2-37-1), compared to the period when AC power came from IC/Gyro (Figure 5).

During HLY12TB, attempts were made to reduce the electrical noise in the ADCP data. Each ADCP deck unit was powered by one double-conversion UPS, which was powered by a 120VAC line from IC/Gyro. We tried changing power source (skipping the UPS and using power from Mica 2-23-1), isolating the deck unit from the rack (rubber pads), and proximity of the OS75 deck unit to the UPS. None of the configurations tested showed any particular improvement (Figure 6). The only thing that decreased the noise was slowing the ship. Although there may be another explanation, the only consistent element in all the bad ADCP data situations is “power from IC/Gyro”.

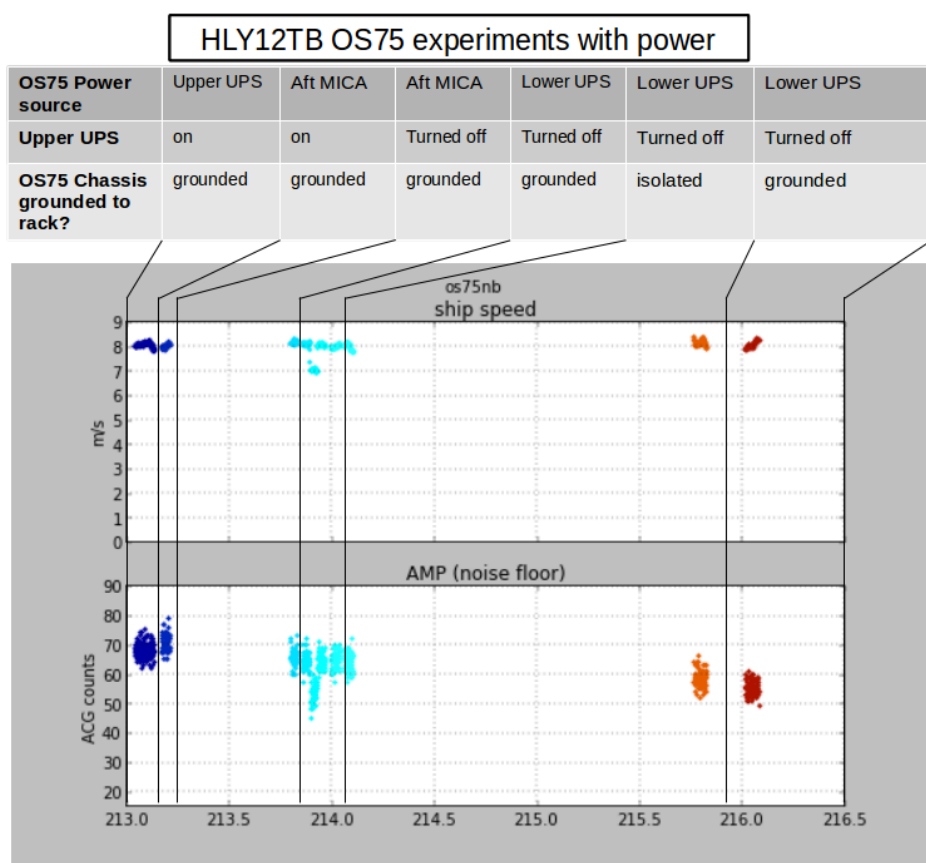


Figure 6: OS75: Ship speed and noise floor during various AC power configurations. Background noise levels are correlated with ship speed: high transit speeds made for a noisy background. Background noise levels apparently decreased over the course of the transit, and when the ship slowed, but no change in AC power configuration affected background noise level.

2.2.3 Bias

High levels of electrical noise can obliterate ADCP data or decrease the range to varying degrees, but can also be associated with biases. Electro-magnetic interference can bias either narrowband mode or broadband mode, or both. Historically on Healy, broadband mode of any ADCP has shown more bias than narrowband mode.

Present calibrations and comparisons indicate that the OS150 broadband mode should not be used because it has strong biases that increase with depth. During the HLY12TB transit, high ship speeds resulted in high background noise and sufficiently poor range that the bias of the OS150BB was hidden. There is a discrepancy between OS150 and OS75 however, which is consistent with a 1.004 scale factor for OS150 (a common value) and 0.997 for OS75 (which is unusually low). These are similar to the values used for processing of HLY1102. These are not applied during at-sea processing, but users should be aware of moderate but unusual scale factors.

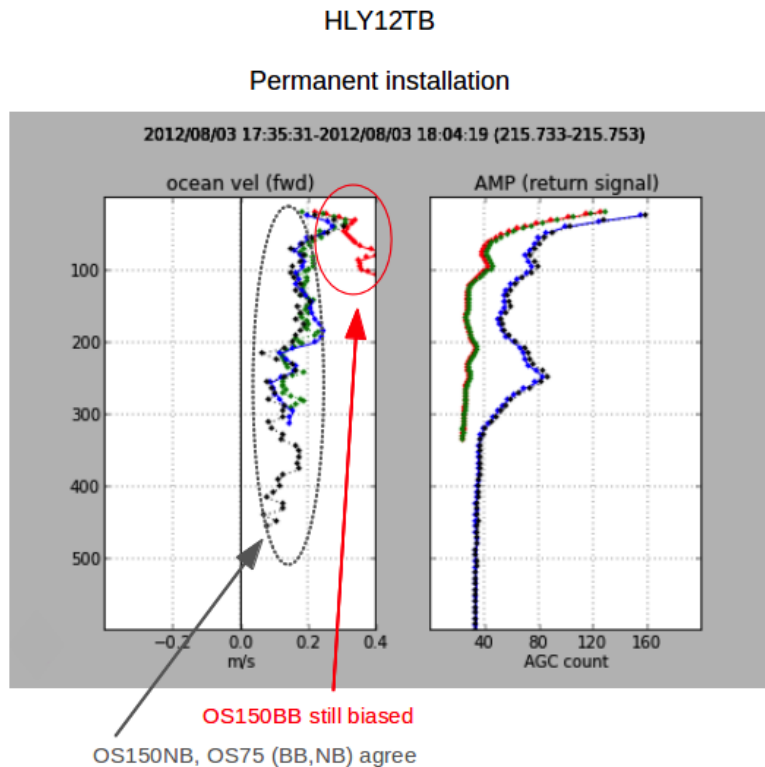


Figure 7: *HLY12TB*: Range and bias at ship speeds of 8kts. Range is poor. All ping types agree except OS150 (broadband mode). OS75 Broadband mode was also biased in deeper bins, but the range was often so poor, this bias was not visible.

3 UHDAS Software Installation

Up through 2009, ADCP acquisition and processing used the software provided by the manufacturer (VmDAS). Each ADCP required one Windows machine running VmDAS, with separate serial feeds to each computer. UHDAS was first installed prior to the 2010 field season and field-tested during the transit from Honolulu to Dutch Harbor. UHDAS can drive both ADCPs from one computer.

VmDAS (running under Windows) and UHDAS (running under Linux) perform must perform some of the same basic tasks. In either case the computer acquires data from the ADCP(s) and other serial feeds (GPS and attitude), timestamps the serial data and it saves to disk. It also adds UTC time and GPS positions to each ADCP ensemble, and transforms the ADCP beam velocities into horizontal velocities referenced to earth. Each system includes averaging and display of various variables. More information about UHDAS is available here: http://currents.soest.hawaii.edu/docs/adcp_doc/index.html

3.1 Computer

Prior to the 2011 field season, a second computer was added, and was field-tested during the 2011 Seattle-San Francisco shakedown cruise (HLY10TA). This computer successfully operated during the 2011 season. It was shut down (becoming the spare) and the computer from the 2010 season was upgraded for the 2012 season. This document describes UHDAS and the installation of the system on the Healy as of June, 2012.

For the 2010 UHDAS installation, LDEO supplied a Dell R210 server, a Digi Neo 8-port PCI serial card (with octocable dongle), installed Ubuntu Hardy Heron (8.04) and a special driver for the Digi. Prior to the 2011 field season, the UHDAS software was upgraded. Serial logging was switched to an 8-port serial-USB logging device with an FTDI chipset whose driver is supported in the kernel. After HLY11TA, a second Dell R210 was provided and a newer operating system (Lucid Lynx, 10.04) was installed. It was configured to match the first, and was tested during the HLY11TB transit to Honolulu. The original computer as IP .35; the second computer has IP (.36). This second computer ran for the 2011 season. The permanent display, mouse, and keyboard reside in the watchstanders' area. Prior to the 2012 HLY12TA science sea trials, the .35 computer was upgraded to Lucid Lynx and the UHDAS software was updated. Now both computers are configured to use the 8-port FTDI chip USB-serial device.

3.2 Serial Ports

UHDAS uses one process per serial port for data acquisition. The input streams are filtered by message, timestamped, and written to a directory named after the instrument being

logged. More than one NMEA string can be acquired from a given serial stream. If the rate of repetition is too high, messages may be subsampled prior to recording. The file `sensor_cfg.py` contains settings for serial acquisition, including ports, baud rates, and message strings. (NOTE that indentation must be respected when editing `sensor_cfg.py`, as it is written in Python). CODAS processing requires position and heading. We try to log all required input types from multiple sources, to allow for reprocessing (in case of gaps or failure in the primary serial feed).

Serial Directory	Instrument	File suffix	Serial messages
ashpaq5	Ashtech adu5	paq	\$GPGGA,\$GPPAT
gpsnav	A-GPS gps	gps	\$GPGGA
gyro	Sperry mk39	hdg	\$INHDT
gyro2	Sperry mk27	hdg	\$HEHDT
os150	RDI adcp (150kHz)	raw, log, log.bin	(binary adcp data + log files)
os75	RDI adcp (75kHz)	raw, log, log.bin	(binary adcp data + log files)
posmv	POSMV	pmv	\$PASHR,\$INGGA

Table 1: *2011/2012 serial messages acquired by UHDAS.*

3.3 UHDAS and CODAS settings

heading (reliable)	position (best)	heading (accurate)	transducer angle (OS75)	transducer angle (OS150)
posmv \$PASHR	posmv \$GPPGA		43.4	28.4

Table 2: *The UHDAS gui starts with defaults for ADCP data acquisition.*

If necessary, processing of UHDAS data can be redone at a later date using different supporting serial strings. Reprocessing of UHDAS data on the Healy should be able to use appropriate settings chosen from:

instrument	position/time	reliable heading	accurate heading
Ashtech	\$GPGGA		\$GPPAT
A-GPS	\$GPGGA		
POSMV	\$INGGA	\$PASHR	\$PASHR
mk39		\$INHDT	

Table 3: *Ancillary data choices for reprocessing ADCP data*

3.4 UHDAS (CODAS) data processing organization

The processing component of UHDAS is called CODAS (Common Ocean Data Access System). Extensive documentation about CODAS processing exists at sea, on ships with UHDAS installed (<http://currents>) on land (http://currents.soest.hawaii.edu/docs/adcp_doc/index.html)

UHDAS data acquisition results in four directories, representing different stages of acquisition/processing. Data in the 'raw' subdirectory, described above, consist of timestamped NMEA messages. Subdirectories 'rbin' and 'gbin' are intermediate (parsed) versions of data in 'raw'. The 'proc' directory contains one directory tree for each instrument+pingtype being processed. This directory tree and the processing steps that occur in it, are described in the CODAS documentation. Processing is done using programs written in Python and C. Parameters used by Python processing are found in each processing directory in a file such as:

- `proc/os150nb/config/HLY12TA_01_proc.py`

The processing directories retain the old Matlab-based configuration files as well:

- `proc/os150nb/config/HLY12TA_01_cfg.m`
- `proc/os150nb/config/HLY12TA_01_proc.m`

Data in the raw subdirectory are organized with one directory per serial port. Files start when data acquisition starts, and roll over on every 2-hour boundary thereafter.

subdirectory	contents	importance	make copies for....
raw	all raw data	critical	archiving
rbin	intermediate files	nice to have	anyone who gets 'raw'
gbin	intermediate files	nice to have	anyone who gets 'raw'
proc	<ul style="list-style-type: none"> · processed data · codas database · underway figure archive · matlab files 	final at-sea product	science CD after cruise

Table 4: *UHDAS data components and associated users*

A Appendix: Cruise Settings

A.1 HLY12TA Settings

A.1.1 Cruise segments (time ranges)

cruise name	date range	comment
HLY12TA_01	2012-06-04 17:54 to 2012-06-06 17:54	· Mostly on IC-GYRO power · first reciprocal runs
HLY12TA_02	2012-06-06 18:00 to 2012-06-07 13:47	· Mostly on MICA power (2-37-1) · second reciprocal runs
HLY12TA_03	2012-06-07 13:51 to 2012-06-07 22:06	· Testing in puget sound

Table 5: *HLY12TA Cruise segments.*

A.1.2 Processing parameters

name	heading (reliable)	best position	accurate heading	h_align OS75	h_align OS150
HLY12TA_01	posmv	posmv		43.4	28.4
HLY12TA_02	posmv	posmv		43.4	28.4
HLY12TA_03	gyro	gpsnav	Ashtech	43.4	28.4

Table 6: *HLY12TA Processing Parameters.*

A.1.3 Acquisition parameters (time ranges)

```

===== HLY12TA_01 =====

----- (os150) -----
0 16 155.746662 156.800462 off (bb, 80, 4.0, 5.0, 4.0) (nb, 80, 4.0, 5.0, 4.0)
1 1 156.803539 156.829815 off (bb, 50, 8.0, 5.0, 8.0) (nb, 80, 4.0, 5.0, 4.0)
2 5 156.831096 157.165246 off (bb, 80, 4.0, 5.0, 4.0) (nb, 50, 8.0, 5.0, 8.0)
3 1 157.178361 157.196398 off (nb, 50, 4.0, 5.0, 4.0)
4 7 157.197284 157.576079 off (bb, 80, 4.0, 5.0, 4.0) (nb, 50, 8.0, 5.0, 8.0)
5 3 157.576808 157.746330 on (nb, 50, 4.0, 5.0, 4.0)

----- (os75) -----
0 16 155.746681 156.800427 off (bb, 80, 8.0, 8.0, 8.0) (nb, 80, 8.0, 8.0, 8.0)
1 1 156.803558 156.829811 off (bb, 50, 16.0, 8.0, 16.0) (nb, 80, 8.0, 8.0, 8.0)
2 5 156.831117 157.165242 off (bb, 80, 8.0, 8.0, 8.0) (nb, 50, 16.0, 8.0, 16.0)
3 1 157.178374 157.196393 off (nb, 70, 8.0, 8.0, 8.0)
4 7 157.197305 157.576045 off (bb, 80, 8.0, 8.0, 8.0) (nb, 50, 16.0, 8.0, 16.0)
5 3 157.576836 157.746345 on (nb, 70, 8.0, 8.0, 8.0)

===== HLY12TA_02 =====

```

```

----- (os150) -----
0 2 157.750896 157.907667 on (nb, 50, 4.0, 5.0, 4.0)
1 2 157.928836 158.003507 on (nb, 50, 4.0, 5.0, 4.0)
2 8 158.004023 158.574133 on (nb, 80, 4.0, 7.0, 4.0)
----- (os75) -----
0 2 157.750916 157.907666 on (nb, 70, 8.0, 8.0, 8.0)
1 2 157.928857 158.003478 on (nb, 70, 8.0, 8.0, 8.0)
2 8 158.004042 158.574116 on (nb, 80, 8.0, 8.0, 8.0)

===== HLY12TA_03 =====

----- (os150) -----
0 2 158.577678 158.595094 off (nb, 80, 4.0, 7.0, 4.0)
----- (os75) -----
0 2 158.577689 158.595084 off (nb, 80, 8.0, 8.0, 8.0)

```

A.1.4 Acquisition parameters (configuration chunks)

```

===== HLY12TA_01 =====

----- (os150) -----
# index (ping, NCells, CellSize, Blank, Pulse) nfiles
0 (bb, 80, 4.0, 5.0, 4.0) 28
1 (nb, 80, 4.0, 5.0, 4.0) 17
2 (bb, 50, 8.0, 5.0, 8.0) 1
3 (nb, 50, 8.0, 5.0, 8.0) 12
4 (nb, 50, 4.0, 5.0, 4.0) 4

----- (os75) -----
# index (ping, NCells, CellSize, Blank, Pulse) nfiles
0 (bb, 80, 8.0, 8.0, 8.0) 28
1 (nb, 80, 8.0, 8.0, 8.0) 17
2 (bb, 50, 16.0, 8.0, 16.0) 1
3 (nb, 50, 16.0, 8.0, 16.0) 12
4 (nb, 70, 8.0, 8.0, 8.0) 4

===== HLY12TA_02 =====

----- (os150) -----
# index (ping, NCells, CellSize, Blank, Pulse) nfiles
0 (nb, 50, 4.0, 5.0, 4.0) 4
1 (nb, 80, 4.0, 7.0, 4.0) 8

----- (os75) -----
# index (ping, NCells, CellSize, Blank, Pulse) nfiles
0 (nb, 70, 8.0, 8.0, 8.0) 4
1 (nb, 80, 8.0, 8.0, 8.0) 8

===== HLY12TA_03 =====

----- (os150) -----
# index (ping, NCells, CellSize, Blank, Pulse) nfiles
0 (nb, 80, 4.0, 7.0, 4.0) 2

----- (os75) -----
# index (ping, NCells, CellSize, Blank, Pulse) nfiles
0 (nb, 80, 8.0, 8.0, 8.0) 2

```

A.1.5 Power source (by file)

cruise leg = HLY12TA_01

hly2012_155_64509	06/04 17:55 - 06/04 17:59	(155.747-155.750)	IC/ship
hly2012_155_64800	06/04 18:00 - 06/04 19:59	(155.750-155.833)	IC/ship
hly2012_155_72000	06/04 20:00 - 06/04 21:04	(155.833-155.878)	IC/ship
hly2012_155_75918	06/04 21:05 - 06/04 21:59	(155.879-155.917)	IC/ship
hly2012_155_79200	06/04 22:00 - 06/04 23:07	(155.917-155.964)	IC/ship
hly2012_155_83378	06/04 23:09 - 06/04 23:59	(155.965-156.000)	IC/ship
hly2012_156_00000	06/05 00:00 - 06/05 01:59	(156.000-156.083)	IC/ship
hly2012_156_07200	06/05 02:00 - 06/05 03:59	(156.083-156.167)	IC/ship
hly2012_156_14400	06/05 04:00 - 06/05 05:59	(156.167-156.250)	IC/ship
hly2012_156_21600	06/05 06:00 - 06/05 07:59	(156.250-156.333)	IC/ship
hly2012_156_28800	06/05 08:00 - 06/05 09:59	(156.333-156.417)	IC/ship
hly2012_156_36000	06/05 10:00 - 06/05 11:59	(156.417-156.500)	IC/ship
hly2012_156_43200	06/05 12:00 - 06/05 13:45	(156.500-156.573)	IC/ship
hly2012_156_49674	06/05 13:47 - 06/05 13:59	(156.575-156.583)	IC/ship
hly2012_156_50400	06/05 14:00 - 06/05 15:59	(156.583-156.667)	IC/ship
hly2012_156_57600	06/05 16:00 - 06/05 17:59	(156.667-156.750)	IC/ship
hly2012_156_64800	06/05 18:00 - 06/05 19:12	(156.750-156.800)	IC/ship
hly2012_156_69423	06/05 19:17 - 06/05 19:54	(156.804-156.830)	IC/ship
hly2012_156_71804	06/05 19:56 - 06/05 19:59	(156.831-156.833)	IC/ship
hly2012_156_72000	06/05 20:00 - 06/05 21:59	(156.833-156.917)	IC/ship
hly2012_156_79200	06/05 22:00 - 06/05 23:59	(156.917-157.000)	IC/ship
hly2012_157_00000	06/06 00:00 - 06/06 01:59	(157.000-157.083)	IC/ship
hly2012_157_07200	06/06 02:00 - 06/06 03:59	(157.083-157.167)	IC/ship
hly2012_157_14400	06/06 04:00 - 06/06 04:13	(157.167-157.176)	IC/ship
hly2012_157_15409	06/06 04:16 - 06/06 04:42	(157.178-157.196)	IC/ups
hly2012_157_17043	06/06 04:44 - 06/06 05:15	(157.197-157.219)	IC/ups
hly2012_157_19764	06/06 05:29 - 06/06 05:34	(157.229-157.232)	os150=IC, os75=2-37-1
hly2012_157_20877	06/06 05:47 - 06/06 05:59	(157.242-157.250)	os150=2-37-1, os75=2-37-1
hly2012_157_21600	06/06 06:00 - 06/06 07:59	(157.250-157.333)	2-37-1
hly2012_157_28800	06/06 08:00 - 06/06 09:59	(157.333-157.417)	2-37-1
hly2012_157_36000	06/06 10:00 - 06/06 11:59	(157.417-157.500)	2-37-1
hly2012_157_43200	06/06 12:00 - 06/06 13:49	(157.500-157.576)	2-37-1
hly2012_157_49834	06/06 13:50 - 06/06 13:59	(157.577-157.583)	2-37-1
hly2012_157_50400	06/06 14:00 - 06/06 15:59	(157.583-157.667)	2-37-1
hly2012_157_57600	06/06 16:00 - 06/06 17:54	(157.667-157.746)	2-37-1

cruise leg = HLY12TA_02

hly2012_157_64875	06/06 18:01 - 06/06 19:59	(157.751-157.833)	2-37-1
hly2012_157_72000	06/06 20:00 - 06/06 21:47	(157.833-157.908)	2-37-1
hly2012_157_80249	06/06 22:17 - 06/06 23:59	(157.929-158.000)	2-37-1
hly2012_158_00000	06/07 00:00 - 06/07 00:05	(158.000-158.004)	2-37-1
hly2012_158_00345	06/07 00:05 - 06/07 01:59	(158.004-158.083)	2-37-1
hly2012_158_07200	06/07 02:00 - 06/07 03:05	(158.083-158.129)	2-37-1
hly2012_158_11200	06/07 03:06 - 06/07 03:59	(158.130-158.167)	2-37-1
hly2012_158_14400	06/07 04:00 - 06/07 05:59	(158.167-158.250)	2-37-1
hly2012_158_21600	06/07 06:00 - 06/07 07:59	(158.250-158.333)	2-37-1
hly2012_158_28800	06/07 08:00 - 06/07 09:59	(158.333-158.417)	2-37-1
hly2012_158_36000	06/07 10:00 - 06/07 11:59	(158.417-158.500)	2-37-1
hly2012_158_43200	06/07 12:00 - 06/07 13:46	(158.500-158.574)	2-37-1

cruise leg = HLY12TA_03

hly2012_158_49910	06/07 13:51 - 06/07 13:59	(158.578-158.583)	2-37-1
hly2012_158_50400	06/07 14:00 - 06/07 15:59	(158.583-158.667)	2-37-1

hly2012_158_57600	06/07 16:00 - 06/07 17:59	(158.667-158.750)	2-37-1
hly2012_158_64800	06/07 18:00 - 06/07 19:59	(158.750-158.833)	2-37-1
hly2012_158_72000	06/07 20:00 - 06/07 20:22	(158.833-158.849)	2-37-1
hly2012_158_73407	06/07 20:23 - 06/07 20:28	(158.850-158.853)	IC/ship
hly2012_158_73856	06/07 20:30 - 06/07 20:34	(158.855-158.858)	2-37-1/ship
hly2012_158_74465	06/07 20:41 - 06/07 20:45	(158.862-158.865)	IC/UPS
hly2012_158_74963	06/07 20:49 - 06/07 20:53	(158.868-158.871)	2-37-1/UPS
hly2012_158_77149	06/07 21:25 - 06/07 21:59	(158.893-158.917)	2-37-1/ship
hly2012_158_79200	06/07 22:00 - 06/07 22:06	(158.917-158.921)	2-37-1/ship

A.2 HLY12TB Settings

A.2.1 Cruise segments (start times)

HLY12TA_01 date	decimal day	comment	gap?
07/30 20:02	211.835	start cruise: IC/Gyro + UPS	
07/30 20:06	211.838	restart logging: IC/Gyro + UPS	
07/30 20:36	211.859	restart logging: aft MICA	
07/30 21:11	211.883	restart logging: IC/Gyro + UPS	Puget sound grooms
07/30 23:45	211.990	restart logging	

Table 7: *HLY12TA_01 cruise segments.*

HLY12TA_02 date	decimal day	comment	
07/31 00:10	212.007	start cruise: IC/Gyro + UPS	
07/31 13:33	212.565	restart logging – BT off	try to move UPS(s); fail
07/31 16:29	212.687	restart logging	underway at 16kts – groom
07/31 22:52	212.953	restart logging	
08/01 00:09	213.006	restart logging (add BB)	change OS75 to aft MICA
08/01 00:54	213.038	restart logging	unplug top UPS
08/01 03:45	213.156	restart logging	plug os75 into lower UPS
08/01 20:14	213.843	restart logging – WT only	
08/01 20:15	213.844	restart logging – WT+BT	
08/01 20:17	213.845	restart logging with WT	deground OS75 (put on foam)
08/02 01:18	214.054	restart logging	

Table 8: *HLY12TA_02 cruise segments.*

HLY12TA_03 date	decimal day	comment
08/02 21:35	214.900	restart logging

Table 9: *HLY12YA_03 cruise segments.*

segment	heading (reliable)	best position	accurate heading	h_align os75	h_align os150
HLY12TB_01	posmv	posmv	(none)	43.4	28.4
HLY12TB_02	gyro	gpsnav	Ashtech	43.4	28.4
HLY12TB_03	posmv	posmv	(none)	43.4	28.4

Table 10: *HLY12TB Processing Parameters.*

A.2.2 Processing parameters

A.2.3 Acquisition parameters

```

===== HLY12TB_01 =====

----- (os150) -----
0 5    211.834974  211.987871    on  (bb, 80, 4.0, 7.0, 4.0)  (nb, 80, 4.0, 7.0, 4.0)
1 2    211.990037  212.005709    off (nb, 80, 4.0, 7.0, 4.0)
----- (os75) -----
0 5    211.835008  211.987882    on  (bb, 80, 8.0, 8.0, 8.0)  (nb, 80, 8.0, 8.0, 8.0)
1 2    211.990048  212.005693    off (nb, 80, 8.0, 8.0, 8.0)

===== HLY12TB_02 =====

----- (os150) -----
0 13   212.007126  212.950471    on  (bb, 80, 4.0, 7.0, 4.0)  (nb, 80, 4.0, 7.0, 4.0)
1 2    212.952841  213.005647    off (nb, 80, 4.0, 7.0, 4.0)
2 14   213.006354  213.843439    off (bb, 80, 4.0, 7.0, 4.0)  (nb, 80, 4.0, 7.0, 4.0)
3 1    213.843990  213.844860    on  (bb, 80, 4.0, 7.0, 4.0)
4 14   213.845391  214.898490    off (bb, 80, 4.0, 7.0, 4.0)  (nb, 80, 4.0, 7.0, 4.0)
----- (os75) -----
0 13   212.007153  212.950460    on  (bb, 80, 8.0, 8.0, 8.0)  (nb, 80, 8.0, 8.0, 8.0)
1 2    212.952852  213.005640    off (nb, 80, 8.0, 8.0, 8.0)
2 14   213.006374  213.843429    off (bb, 80, 8.0, 8.0, 8.0)  (nb, 80, 8.0, 8.0, 8.0)
3 1    213.844013  213.844860    on  (bb, 80, 8.0, 8.0, 8.0)
4 14   213.845411  214.898500    off (bb, 80, 8.0, 8.0, 8.0)  (nb, 80, 8.0, 8.0, 8.0)

===== HLY12TB_03 =====

----- (os150) -----
0 31   214.899772  216.959706    off (bb, 80, 4.0, 7.0, 4.0)  (nb, 80, 4.0, 7.0, 4.0)
----- (os75) -----
0 16   214.899791  216.002191    off (bb, 80, 8.0, 8.0, 8.0)  (nb, 80, 8.0, 8.0, 8.0)
1 3    216.002893  216.191096    off (bb, 80, 8.0, 8.0, 8.0)  (nb, 60, 16.0, 8.0, 16.0)
2 12   216.191670  216.959693    off (bb, 80, 8.0, 8.0, 8.0)  (nb, 80, 8.0, 8.0, 8.0)

```

A.2.4 Power source (by file)

(*) restart logging

cruise leg = HLY12TB_01
gyro for heading, corrected to posmv

```

hly2012_211_72138 * 07/30 20:02 - 07/30 20:05 (211.835-211.837) start cruise: IC/Gyro + UPS
hly2012_211_72411 * 07/30 20:06 - 07/30 20:36 (211.838-211.858) restart logging: IC/Gyro + UPS
hly2012_211_74205 * 07/30 20:36 - 07/30 21:11 (211.859-211.883) restart logging: aft MICA
hly2012_211_76308 * 07/30 21:11 - 07/30 21:59 (211.883-211.917) restart logging: IC/Gyro + UPS
hly2012_211_79200 07/30 22:00 - 07/30 23:42 (211.917-211.988) (continue logging)
Puget sound grooms
hly2012_211_85538 * 07/30 23:45 - 07/30 23:59 (211.990-212.000) restart logging
hly2012_212_00000 07/31 00:00 - 07/31 00:08 (212.000-212.006) (continue logging)

cruise leg = HLY12TB_02
gyro for heading, corrected to ashtech

hly2012_212_00612 * 07/31 00:10 - 07/31 01:59 (212.007-212.083) start cruise: IC/Gyro + UPS
hly2012_212_07200 07/31 02:00 - 07/31 03:59 (212.083-212.167) (continue logging)
hly2012_212_14400 07/31 04:00 - 07/31 05:59 (212.167-212.250) (continue logging)
hly2012_212_21600 07/31 06:00 - 07/31 07:59 (212.250-212.333) (continue logging)
hly2012_212_28800 07/31 08:00 - 07/31 09:59 (212.333-212.417) (continue logging)
hly2012_212_36000 07/31 10:00 - 07/31 11:59 (212.417-212.500) (continue logging)
hly2012_212_43200 07/31 12:00 - 07/31 13:33 (212.500-212.565) (continue logging)
hly2012_212_48834 * 07/31 13:33 - 07/31 13:59 (212.565-212.583) restart logging -- BT off
hly2012_212_50400 07/31 14:00 - 07/31 15:45 (212.583-212.657) (continue logging)
try to move UPS(s); fail
hly2012_212_59372 * 07/31 16:29 - 07/31 17:59 (212.687-212.750) restart logging
hly2012_212_64800 07/31 18:00 - 07/31 19:59 (212.750-212.833) (continue logging)
hly2012_212_72000 07/31 20:00 - 07/31 21:59 (212.833-212.917) (continue logging)
hly2012_212_79200 07/31 22:00 - 07/31 22:48 (212.917-212.950) (continue logging)
underway at 16kts -- groom
hly2012_212_82324 * 07/31 22:52 - 07/31 23:59 (212.953-213.000) restart logging
hly2012_213_00000 08/01 00:00 - 08/01 00:08 (213.000-213.006) (continue logging) oops -- only NB
hly2012_213_00546 08/01 00:09 - 08/01 00:54 (213.006-213.038) restart logging (add BB back in)
change OS75 to aft MICA
hly2012_213_03292 08/01 00:54 - 08/01 01:59 (213.038-213.083) restart logging
hly2012_213_07200 08/01 02:00 - 08/01 02:01 (213.083-213.084) (continue logging)
hly2012_213_07200 08/01 02:00 - 08/01 03:22 (213.083-213.140)
unplug top UPS
hly2012_213_13501 08/01 03:45 - 08/01 03:59 (213.156-213.167) (continue logging)
hly2012_213_14400 08/01 04:00 - 08/01 05:59 (213.167-213.250) (continue logging)
hly2012_213_21600 08/01 06:00 - 08/01 07:59 (213.250-213.333) (continue logging)
hly2012_213_28800 08/01 08:00 - 08/01 09:59 (213.333-213.417) (continue logging)
hly2012_213_36000 08/01 10:00 - 08/01 11:59 (213.417-213.500) (continue logging)
hly2012_213_43200 08/01 12:00 - 08/01 13:59 (213.500-213.583) (continue logging)
hly2012_213_50400 08/01 14:00 - 08/01 15:59 (213.583-213.667) (continue logging)
hly2012_213_57600 08/01 16:00 - 08/01 17:59 (213.667-213.750) (continue logging)
hly2012_213_64800 08/01 18:00 - 08/01 19:59 (213.750-213.833) (continue logging)
hly2012_213_72000 08/01 20:00 - 08/01 20:13 (213.833-213.843) (continue logging)
plug os75 into lower UPS
hly2012_213_72846 08/01 20:14 - 08/01 20:14 (213.843-213.843) restart logging -- check with WT only
hly2012_213_72918 08/01 20:15 - 08/01 20:16 (213.844-213.845) - check with WT+BT
hly2012_213_73039 08/01 20:17 - 08/01 21:59 (213.845-213.917) restart logging with WT+BT
hly2012_213_79200 08/01 22:00 - 08/01 23:59 (213.917-214.000) (continue logging)
hly2012_214_00000 08/02 00:00 - 08/02 01:17 (214.000-214.054) (continue logging)
deground OS75 (put on foam)
hly2012_214_04699 08/02 01:18 - 08/02 01:59 (214.054-214.083) restart logging
hly2012_214_07200 08/02 02:00 - 08/02 03:59 (214.083-214.167) (continue logging)
hly2012_214_14400 08/02 04:00 - 08/02 05:59 (214.167-214.250) (continue logging)
hly2012_214_21600 08/02 06:00 - 08/02 07:59 (214.250-214.333) (continue logging)
hly2012_214_28800 08/02 08:00 - 08/02 09:59 (214.333-214.417) (continue logging)
hly2012_214_36000 08/02 10:00 - 08/02 11:59 (214.417-214.500) (continue logging)
hly2012_214_43200 08/02 12:00 - 08/02 13:59 (214.500-214.583) (continue logging)
hly2012_214_50400 08/02 14:00 - 08/02 15:59 (214.583-214.667) (continue logging)
hly2012_214_57600 08/02 16:00 - 08/02 17:59 (214.667-214.750) (continue logging)
hly2012_214_64800 08/02 18:00 - 08/02 19:59 (214.750-214.833) (continue logging)
hly2012_214_72000 08/02 20:00 - 08/02 21:33 (214.833-214.899) (continue logging)

```

cruise leg = HLY12TB_03

gyro for heading, corrected to posmv

```

hly2012_214_77738 08/02 21:35 - 08/02 21:59 (214.900-214.917) start cruise,
hly2012_214_79200 08/02 22:00 - 08/02 23:51 (214.917-214.994) (continue logging)
hly2012_214_85949 08/02 23:52 - 08/02 23:59 (214.995-215.000) turn off os75bb
hly2012_215_00000 08/03 00:00 - 08/03 01:59 (215.000-215.083) (continue logging)
hly2012_215_07200 08/03 02:00 - 08/03 03:59 (215.083-215.167) (continue logging)
hly2012_215_14400 08/03 04:00 - 08/03 05:59 (215.167-215.250) (continue logging)
hly2012_215_21600 08/03 06:00 - 08/03 07:59 (215.250-215.333) (continue logging)
hly2012_215_28800 08/03 08:00 - 08/03 09:59 (215.333-215.417) (continue logging)
hly2012_215_36000 08/03 10:00 - 08/03 11:59 (215.417-215.500) (continue logging)
hly2012_215_43200 08/03 12:00 - 08/03 13:59 (215.500-215.583) (continue logging)
hly2012_215_50400 08/03 14:00 - 08/03 15:59 (215.583-215.667) (continue logging)
hly2012_215_57600 08/03 16:00 - 08/03 17:59 (215.667-215.750) (continue logging)
hly2012_215_64800 08/03 18:00 - 08/03 19:59 (215.750-215.833) (continue logging)
hly2012_215_72000 08/03 20:00 - 08/03 21:59 (215.833-215.917) (continue logging)
hly2012_215_79200 08/03 22:00 - 08/03 23:59 (215.917-216.000) (continue logging)
hly2012_216_00000 08/04 00:00 - 08/04 00:03 (216.000-216.002) (continue logging)
hly2012_216_00245 08/04 00:04 - 08/04 01:59 (216.003-216.083) change os75nb to 16m bins
hly2012_216_07200 08/03 20:00 - 08/03 21:59 (215.833-215.917) (continue logging)
hly2012_215_79200 08/03 22:00 - 08/03 23:59 (215.917-216.000) (continue logging)
hly2012_216_00000 08/04 00:00 - 08/04 00:03 (216.000-216.002) (continue logging)
hly2012_216_00245 08/04 00:04 - 08/04 01:59 (216.003-216.083) (continue logging)
hly2012_216_07200 08/04 02:00 - 08/04 03:59 (216.083-216.167) (continue logging)
hly2012_216_14400 08/04 04:00 - 08/04 04:35 (216.167-216.191) (continue logging)
hly2012_216_16556 08/04 04:35 - 08/04 05:59 (216.192-216.250) (continue logging)
hly2012_216_21600 08/04 06:00 - 08/04 07:59 (216.250-216.333) (continue logging)
hly2012_216_28800 08/04 08:00 - 08/04 09:59 (216.333-216.417) (continue logging)
hly2012_216_36000 08/04 10:00 - 08/04 11:59 (216.417-216.500) (continue logging)
hly2012_216_43200 08/04 12:00 - 08/04 13:59 (216.500-216.583) (continue logging)
hly2012_216_50400 08/04 14:00 - 08/04 14:37 (216.583-216.609) (continue logging)
hly2012_216_52661 08/04 14:37 - 08/04 15:59 (216.610-216.667) turn on bottom track for both
hly2012_216_57600 08/04 16:00 - 08/04 17:12 (216.667-216.717) (continue logging)
hly2012_216_61981 08/04 17:13 - 08/04 17:59 (216.717-216.750) turn BT off again
hly2012_216_64800 08/04 18:00 - 08/04 19:59 (216.750-216.833) (continue logging)
hly2012_216_72000 08/04 20:00 - 08/04 21:59 (216.833-216.917) (continue logging)
hly2012_216_79200 08/04 22:00 - 08/04 23:01 (216.917-216.960) (continue logging)

```

stop logging, end cruise leg

B Appendix: HLY12TB grooms

B.1 OS150 groom

UHDAS file: termos150log2012_212_82149.txt

----- (os150) -----

Ocean Surveyor Broadband/Narrowband ADCP

Teledyne RD Instruments (c) 1997-2008

All rights reserved.

Firmware Version: 23.17

>TS?

TS 12/07/31,22:49:45.75 ----- Set System Date and Time

>ps0

Frequency: 153600 HZ

Configuration: 4 BEAM, JANUS

```

Transducer Type:  ROUND 32x32
Beamformer Rev:   A02 or later
  Beam Angle:     30 DEGREES
  Beam Pattern:   CONVEX
  Orientation:    DOWN
  CPU Firmware:   23.17
  FPGA Version:   AA
  Sensors:        TEMP  SYNCHRO

```

```

>pa
RAM test.....PASS
ROM test.....PASS
Receive test.....PASS
Bandwidth test.....PASS

```

>

```

>pc2
Heading      Pitch      Roll      Temperature
(int)        (int)      (int)      cts    degs
000.0        +00.0      +00.0      0929   14.5

```

>pt3

```

Correlation Magnitude:
  Lag    Bm1    Bm2    Bm3    Bm4
  0      1.00   1.00   1.00   1.00
  1      0.83   0.82   0.82   0.82
  2      0.46   0.45   0.45   0.45
  3      0.17   0.15   0.15   0.16
  4      0.03   0.04   0.03   0.03
  5      0.00   0.02   0.03   0.03
  6      0.03   0.03   0.04   0.04
  7      0.05   0.02   0.05   0.04

```

RSSI: 44 58 57 50

PASSED

>pt5

CAUTION: This test will transmit, which may damage the power supply if the transducer is not in water.

Continue (yes or no)? yes

```

Correlation Data:          Amplitude Data:
Bin 0:  12   0   8   0   26  26  29  32
Bin 1:  12   0  12   0  221 217 218 218
Bin 2:  12   8  12   0  223 218 220 220
Bin 3:  12   0   8   0  223 219 219 219
Bin 4: 254 254 254 254  223 218 220 220
Bin 5:  12   8  12   0  223 219 220 220
Bin 6:  12   8  12   0  223 219 220 220
Bin 7: 254 254 254 254  223 219 219 219
Bin 8:   8   8  12   0  223 218 219 219
Bin 9:  12   8  12   0  223 219 220 220
Bin 10: 12   8  12   0  223 219 220 220
Bin 11: 254 254 254 254

```

>pt6

```

Receive Bandwidth:
.....
Expected    Bm1    Bm2    Bm3    Bm4
-----
  15500      14783  14753  14881  14715

```

PASSED

B.2 HLY12TB OS75 groom

UHDAS file: termos75log2012_212_82149.txt

----- (os75) -----

Ocean Surveyor Broadband/Narrowband ADCP
Teledyne RD Instruments (c) 1997-2008
All rights reserved.
Firmware Version: 23.17

>TS?

TS 12/07/31,22:49:50.66 ----- Set System Date and Time

>ps0

Frequency: 76800 HZ
Configuration: 4 BEAM, JANUS
Transducer Type: ROUND 32x32
Beamformer Rev: A02 or later
Beam Angle: 30 DEGREES
Beam Pattern: CONVEX
Orientation: DOWN
CPU Firmware: 23.17
FPGA Version: AA
Sensors: TEMP SYNCHRO

>pa

RAM test.....PASS
ROM test.....PASS
Receive test.....PASS
Bandwidth test.....PASS

>pc2

Heading (int)	Pitch (int)	Roll (int)	Temperature cts degs	
000.0	+00.0	+00.0	0928	14.5

>pt3

Correlation Magnitude:

Lag	Bm1	Bm2	Bm3	Bm4
0	1.00	1.00	1.00	1.00
1	0.80	0.81	0.82	0.82
2	0.41	0.41	0.44	0.46
3	0.11	0.12	0.15	0.18
4	0.04	0.09	0.07	0.09
5	0.03	0.06	0.04	0.08
6	0.02	0.02	0.00	0.05
7	0.04	0.02	0.03	0.02

RSSI: 70 58 58 70

PASSED

>pt5

CAUTION: This test will transmit, which may damage the
power supply if the transducer is not in water.

Continue (yes or no)? yes

```

Correlation Data:
Bin 0:  0  0  0  0  104  98  83 105
Bin 1:  0  0  0  0  227 212 212 211
Bin 2:  0  0  0  0  227 213 213 211
Bin 3:  0  0  0  0  227 213 212 212
Bin 4: 254 254 254 254 227 213 212 212
Bin 5:  0  0  0  0  227 213 213 212
Bin 6:  0  0  0  0  227 210 211 211
Bin 7: 254 254 254 254 227 213 212 211
Bin 8:  0  0  0  0  227 213 212 211
Bin 9:  0  0  0  0  227 212 212 212
Bin 10: 0  0  0  0  227 214 213 212
Bin 11: 254 254 254 254

```

```
>pt6
```

```
Receive Bandwidth:
```

```

.....
Expected  Bm1  Bm2  Bm3  Bm4
-----
    7750    7501 7348 7215 7224

```

```
PASSED
```

C Appendix: Installation Photos



(a) View of aft Mica: cables come from below deck (b) View from aft Mica center, cables run towards starboard

Figure 8: ADCP Transducer cable route in aft MICA



(a) *HLY12TA temporary installation* (b) *HLY12TB permanent installation*

Figure 9: *Deck unit installations*