Neil Armstrong UHDAS installation and ADCP evaluation

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Revision History

02/27/16	draft#1
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1 Hardware and software setup

RV Neil Armstrong has three Acoustic Doppler Current Profilers (ADCPs) made by Teledyne RDI. These instruments are used to determine ocean currents beneath the ship. Data acquisition and processing at sea will be performed by the University of Hawaii Data Acquisition System (UHDAS), written and maintained by the University of Hawaii ADCP group. This document describes UHDAS and the installation of the system on the *Neil*

Armstrong as of late February, 2016.

1.1 ADCPs

There are three Teledyne R.D.Instruments ADCPS: a 300kHz Workhorse and one each 150kHz and 38 kHz phased array Ocean Surveyor models (OS150 and OS38). All transducers are behind windows. The fluid in all three transducers wells (plus perhaps others) are interconnected with one fill/bleed valve. The wells are supposedly filled with fresh water, but at least one window cracked during installation and the fluid communication between the wells leaves the salinity in each well unknown.

Ocean Surveyors are phased array ADCPs with a flat face made up of many small transducers. They can ping in broadband mode or narrowband mode. The OS150 and OS38 therefore create up to four datasets between them: OS150BB, OS150NB, OS38BB, and OS38NB (for broadband and narrowband mode). With the WH300, that means the *Neil Armstrong* has up to 5 separate ADCP datasets (instrument+pingtype combinations).

1.2 Computer

1.2.1 Computer overview

Two computers were purchased by WHOI for UHDAS ADCP data acquisition. Both are configured with the same settings, and both are tested. These computers were set up in 2015 with 64-bit Xubuntu 14.04. The operating system and code base were updated at WHOI in February 2016 just prior to the sonar Sea Acceptance Trials (Feb 9-17, 2016). Each computer has two hard drives, a 1Tb system disk where primary data acquisition occurs, and a secondary 2Tb drive which serves as a data backup disk. The acquisition software gathers data from the ADCP and other serial feeds through an 8-port serial-USB device which uses FTDI chips for communication. Each computer has additional on-board serial ports. An attempt was made to use these serial ports, but they did not seem to be functioning under the current operating system as configured. That may or may not be worth pursuing.

1.2.2 UHDAS overview

UHDAS logs and timestamps ADCP data from the WH300, OS150, and OS38 as well as heading (Gyro-Sperry1, Gyro-Sperry2, POSMV) and GPS positions (from CNAV and POSMV), and writes them to disk. During the processing stage, ADCP beam velocities are transformed into horizontal velocities and referenced to earth prior to automated editing and averaging. A daily email is automatically generated, which contains a snippet of processed data as well as diagnostics related to data acquisition, processing and computer system. The email is sent to shore, where it is monitored by UHDAS personnel, and where figures are generated from the data snippet. Information from the email is available at this shoreside web site: http://currents.soest.hawaii.edu/uhdas_fromships.html

The UHDAS software populates a website with a variety of plots and links to data and documentation. The website and all of the raw and processed data should be accessible to scientists on board. The UHDAS computers are on the “data” network, not directly accessible to the “science” network,where scientists have their computers. WHOI forwards the web site to the science network, so once DNS is working, the web site should be available on the science network by computer name. Until then, the IP number will work. WHOI's approach to making the data available to the science network is to frequently rsync the data from the active cruise directory to a location accessible by computers on the science network. This scheme is not ideal, but is sufficient to allow a scientist to process the raw data on their own computer as frequently as the automated processing runs.

1.2.3 Serial Feeds

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 (eg. both gyros on *Neil Armstrong*). 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 messages logged

Serial (raw) directory	instrument	suffix	messages	serial port /dev/tty/
posmv	POS/MV	'gps', 'pmv'	'$INGGA', '$PASHR'	USB4
cnav	CNAV GPS	gps	$GPGGA,'$GNGGA', '$INGGA',	USB5
gyro	Sperry	hdg	$HEHDT	USB7
gyro2	Sperry	hdg	$HEHDT	USB6
phins	PhinsIII	hdg	$HEHDT	USB3
wh300	wh300	raw, log, log.bin	(binary adcp data + log files)	USB0
os150	RDI ADCP (150kHz)	raw, log, log.bin	(binary adcp data + log files)	USB1
os38	RDI ADCP (38kHz)	raw, log, log.bin	(binary adcp data + log files)	USB2

Table 1: The PhinsIII might be an accurate heading device that could improve the ADCP data quality, but there is no access to that device at present. Logging the Phins with UHDAS and comparing it to the POSMV would allow an easy method of Phins data quality evaluation. If it is well-calibrated, it should be made available for science use as a spare accurate heading device.

NOTE:

The ports used by the UHDAS computer are numbered 0,1,...7 (not 1,2,..8)

1.2.4 CODAS processing settings

Transducer-dependent settings:

instrument	transducer angle	cnav offset (starboard)	cnav offset (fwd)
wh300	54.4	12m	4m
os150	43.1	12m	6m
os38	54.4	12m	7m

Table 2: transducer-dependent setting. If a different position device is used for processing, the transducer-GPS offsets will have to be changed.

Three types of ancillary data are used for automated at-sea processing: position, reliable heading (gyro), and accurate heading. Those are highlighted below. If necessary, processing of UHDAS data can be redone at a later date using different supporting serial strings. Should there be a problem with the primary data feeds, reprocessing of UHDAS data on *Neil Armstrong* should be able to use appropriate settings chosen from the following.

instrument	position/time	reliable heading	accurate heading
posmv	$GPGGA		$PASHR
phins			???
cnav	$xxGGA		
gyro		$HEHDT	
gyro2		$HEHDT	

Table 3: subdirectory and ancillary NMEA serial message logged.

Additional information about CODAS processing and UHDAS can be found here: http://currents.soest.hawaii.edu/docs/adcp_doc/index.html. Other reports are stored on line at http://currents.soest.hawaii.edu/reports/ship_reports/

2 ADCP Evaluation

2.1 Overview

UHDAS was run with all ADCPs pinging whenever possible; Ocean Surveyors had both BB and NB modes enabled. Defaults for each instrument and each ping type (and blanking) were the defaults recommended by the manufacturer with the exception of the OS38, where the bins are about 75% of the default. WH300 data were processed using 2min averaging, all the rest were processed using 5min averaging. These intervals cannot be changed in the at-sea automated processing. Periods of evaluation included Bottom Tracking on the way out of port, some transits between Multibeam test locations, and during periods of the multibeam acceptance trials when the EM710 was not being tested or calibrated. In general, they were not synchronized. The Multibeam Advisory Committee, with grudging agreement by Konsgburg, determined that none of the ADCPs interfered with the EM122. Therefore all ADCPs were run while the EM122 patch test was underway, with no discernible adverse effects on the EM122 for that test.

RDI SAT tests nor run:

- explicit speed vs range test
- comprehensive interference testing

2.1.1 Default instrument settings (accessible via the UHDAS GUI)

	WH300	OS150BB (off)	OS150NB	OS38BB (off)	OS38NB
blank	4m	6m	6m	16m	16m
bin (pulse)	2m	4m	8m	12m	16m
bottomtrack	ON	OFF	OFF	OFF	OFF
triggering	OFF	OFF	OFF	OFF	OFF

2.2 Calibrations - phase and amplitude

Transducer angle was determined using data collected with Bottom Tracking on, and periods and the when the ship was maneuvering (CODAS watertrack calibration). The POSMV was not yet working well during the early outbound leg, but changes were made to improve the data, so only the very early part needed to be discarded. The best cruise track for phase calibration was the EM122 patch test, but the ocean currents were strong and variable, making a good phase determination difficult. This also complicated the amplitude determination, since bad weather and bubbles tend to introduce along-track biases.

Ocean Surveyors should not need an amplitude calibration applied (scale factor), but it is common for them to require 1.003-1.005. The OS150 data from this cruise required 1.014, which is quite high. This was consistent with the CODAS watertrack calibration of both, and the comparison between them. Whether that scale factor was anomalous to this cruise remains to be determined. The OS38 did not require any scale factor. Discrete ceramic transducers, such as the WH300, require that the soundspeed be known at the transducer. For this ship, the WH300 well water communicates with the water in other wells, and at least one of them is cracked. Therefore, there will be an unknown salinity in the WH300 well until the well is fixed. Correcting that in the data will require scale factor to be applied in post-processing. That correction will not be applied in the at-sea processing.

2.3 Range

Range is a function of ship speed and weather (bubbles), and distribution of scatterers in the ocean. This means the range of a given ADCP will depend on the species numbers and composition where the data are collected. In a biological desert, ADCP range will be reduced. Range can also be variable at a given location: since the animals have a diurnal vertical migration pattern, the vertical range of the instrument can vary in a 24-hour period.

Generally, a faster ship is noisier and range decreases as ship speed increases. Bubbles are more complicated as they affect broadband and narrowband pings differently, and tend to block and bias the single pings. Poor weather and bubbles reduce the range, but more fundamentally often reduce the data quality to the point where range is irrelevant, i.e. there is not much data left and it is biased or otherwise untrustworthy.

Ranges determined during ADCP testing:

WH300 (2m bins)	OS150 broadband (4m bins)	OS150 narrowband (8m bins)	OS38 broadband (12m bins)	OS38 narrowband (24m bins)
50m-75m	120m-170m	180m-220m	900m-1200m	1000m-1800m

Table 4: Ranges from this cruise may not represent ranges from other regions with more scattering.

2.4 Bubbles

All three instruments were affected by bubbles. This was most notable during the EM122 patch test over Blake Nose, when the ship ran reciprocal tracks in windy conditions with swell coming from a nearby storm. The cruise track and resulting data quality illustrated the difference the sea state and ship direction can have on ADCP data.

Bubbles cause trouble primarily in several ways:

(1) a bubble plume blocks the outgoing signal completely (no sound is returned from that ping, so no velocity at all). This reduces the Percent Good of the averaging period because there are no velocities to start with.

(2) a bubble plume distorts the outgoing ping resulting in a short profile, biased towards zero measured velocity. These short profiles must be edited out prior to averaging or there will be underway bias towards zero in the measured velocity, resulting in a bias in the ship's direction of motion in the ocean velocity

(3) bubbles can distort the return ping, sometimes subtly, with a bias towards zero in the measured velocity near the ship, with less bias farther way. Range of these profiles is reduced.

All instruments had pings blocked by bubbles (i.e. reduced numbers of valid bins available). The WH300 and OS150BB and OS150NB had short, biased profiles. After automated single-ping editing, all three still showed signs of underway bias in the remaining pings when the remaining Percent Good was generally low (not exceeding 80%). This bias was pronounced near the surface where percent good was 50%-60%. It is possible that further tweaking of the single-ping editing criteria might lessen these biases. That will be investigated. The OS38 did not have these biases; it simply did not report much data at all (i.e. the data were missing, not incorrect). The range of all instruments decreased slightly in heavy seas, but the largest effects were (1) underway biases and (2) loss of data. Figures below will illustrate the loss of data.

2.5 Biases Unrelated to Bubbles

Since the velocities from all instruments and settings should agree, comparisons between ping types and instruments are a way to reveal problems. One typical cause of a difference between BB and NB modes is electrical interference (ground loops). Comparisons between BB and NB mdoe for OS150 and OS38 indicated no systematic differences based on pingtype.

The OS150 and OS38 differed in the along-track direction, but a small independently-determined scale factor applied to each dataset decreased that difference to only a few cm/s. There was no indication of ringing in either instrument when the default blanking interval was used.

The WH300 showed some ringing with the default blanking interval of 2m, so the default is 3m.

2.6 Acoustic Interference and (K-Sync) triggering

All of these instruments rely on backscattered sound, but use it in different ways. ADCPs measure the Doppler shift caused by the component of velocity measured along each of the 4 beams. Given typical ocean velocities, this is a small quantity that can be difficult to isolate, particularly from the weak returns at the edge of the instrument's range. Therefore, the measurement is inherently noisy, and many pings (on the order of 50 to 300 in a 5 minute averaging period) are needed to adequately determine ocean velocities.

Since these various sonars can interfere with each other, it is natural to try timing their pings in such a way as to minimize this interference. *Neil Armstrong* has a device (a Kongsberg K-Sync) designed to enable this. Unfortunately this approach can also damage the data. For the ADCPs there are two problems :

(1) It reduces the number of pings. Since the Doppler measurement is inherently noisy, reducing the ping rate increases the uncertainty of the results. If the number of pings

drops too low, the data become essentially worthless.

(2) If there is still interference, synchronized ping timing ensures that the interference is always at the same depth. This means there will be no valid data at all from that depth. Since interference can usually be edited out by the automatic processing, the ADCPs acquired with UHDAS work better with the pseudo-randomly distributed noise from uncoordinated pinging, even if the total amount of interference is greater.

If an Ocean Surveyor is triggered, only use one pingtype (BB or NB, but not both)

If there is no science mandate otherwise, the ADCPs should not be synchronized to other devices. If there is a scientific need to run the ADCPs and synchronize them with other devices (eg. EK80), proper settings should be used. There was insufficient time during these tests to learn what settings are most appropriate.

Some attempts were made to test interference between instruments. Interference tests are time-consuming to carry out thoroughly, time-consuming to evaluate, and require that other sonars be secured for much of the testing period., therefore comprehensive interference testing is not possible when there are multiple sonar evaluation agendas on the same cruise. Nevertheless we tried to address three questions:

(1) why is the WH300 percent good so low? (AR0103_11)

(2) Can any/all of the ADCP instrument+pingtype configurations be run simultaneously? The only test run here was to look at the effect of the OS38BB and OS38NB on the WH300, OS150BB, and OS150NB. (AR0103_08).

(3) What was the effect of triggered and asynchronous pinging of the EM710, EK80 and Knutsen on the OS150? (AR0103_12). There are multiple frequencies in the EK80, and multiple settings for both EM710 and Knutsen, but only one “typical” setting was tested.

General observations were:

- To do a good job with interference tests, it is best to
  - secure **ALL** other sonars, and that includes the bridge speedlog. Check again.
  - test only one instrument at a time
- WH300:
  - WH300 cannot be triggered (requires a special board in the deck unit)
  - Everything interferes with the WH300
  - The more sonars running, the worse its Percent Good will be, and the harder it is to edit out acoustic interference
- All the ADCPs were able to edit out the single-ping interference from other sonars, provided they are run in an uncoordinated manner (not triggered). The interference is visible and affects the data if untreated, but the CODAS single-ping editing can remove it.
- When the EM710 is used to trigger the OS150, it damages the data by:
  - decreasing the ping rate
  - biasing or obliterating the top 30%-50% of the bins

– The EM122 was not affected by any of the ADCPs (MAC observation)
– These interference tests should be repeated, but with each ADCP running alone. To save time, they could be run with both broadband and narrowband modes enabled.

The MAC (Multibeam Advisory Committee) indicated that none of the ADCPs significantly impacts EM122 deep multibeam sonar bathymetry mapping (EM710 is adversely affected). If science cruise requirements need EM710 water or bottom-return data, or EM122 water-column data, it is up to the science team to decide whether to secure or trigger the ADCPs, with the knowledge that the upper 50-150m of ADCP data might be destroyed, and a low pingrate would also damage the ADCP data. It might still be worth it to run the OS38NB to get deep ocean currents, of that was feasible.

3 Recommendations

3.1 Installation

The WH300 should be in fresh water or ocean water, but an unknown salinity makes proper calibration difficult. It would be better to remove the window from the WH300.

3.2 Operations

Because both OS150 and OS38 both appear to be working, and because NB mode is the deepest, most robust setting, defaults will be set to OS150NB (8m) and OS38NB (24m). There is no problem running either instrument in broadband mode if science on a cruise warrants it. For higher-resolution data, it might make sense to run the OS150 with BB and NB modes, since the WH300 seems to be weak and vulnerable to every other ping. Broadband mode does have higher accuracy (can use smaller bins) but is far more prone to fail in the presence of bubbles or lack of scattering.

In general:

(1) Run the ADCPs with their default settings as much as possible
(2) Do not synchronize the ADCPs unless the scientific mission requires it
(3) Sea state will affect data quality and range
(4) Default settings for WH300: 2m bins, 120sec averages, bottom track on if under 100m.
(5) Default settings for OS150: 8-m bins, narrowband mode, no bottom track
(6) Default settings for OS38: 24-m bins, narrowband mode, no bottom track
(7) There is little point in running the OS38 over the shelf

4 Figures

Figure 3: OS150BB and OS150NB during the EM122 patch test (including velocity)
Figure 4: OS38BB and OS38NB during the EM122 patch test
Figure 5: Ship speed and range shown for all 5 ADCP/pingtype combinations.
Figure 6: Acoustic interference example: Knutsen affecting WH300
Figure 7: WH300: effect of acoustic interference on available data (decrease in Percent Good)
Figure 8: Acoustic interference and bubbles, and the resulting edited single-ping data

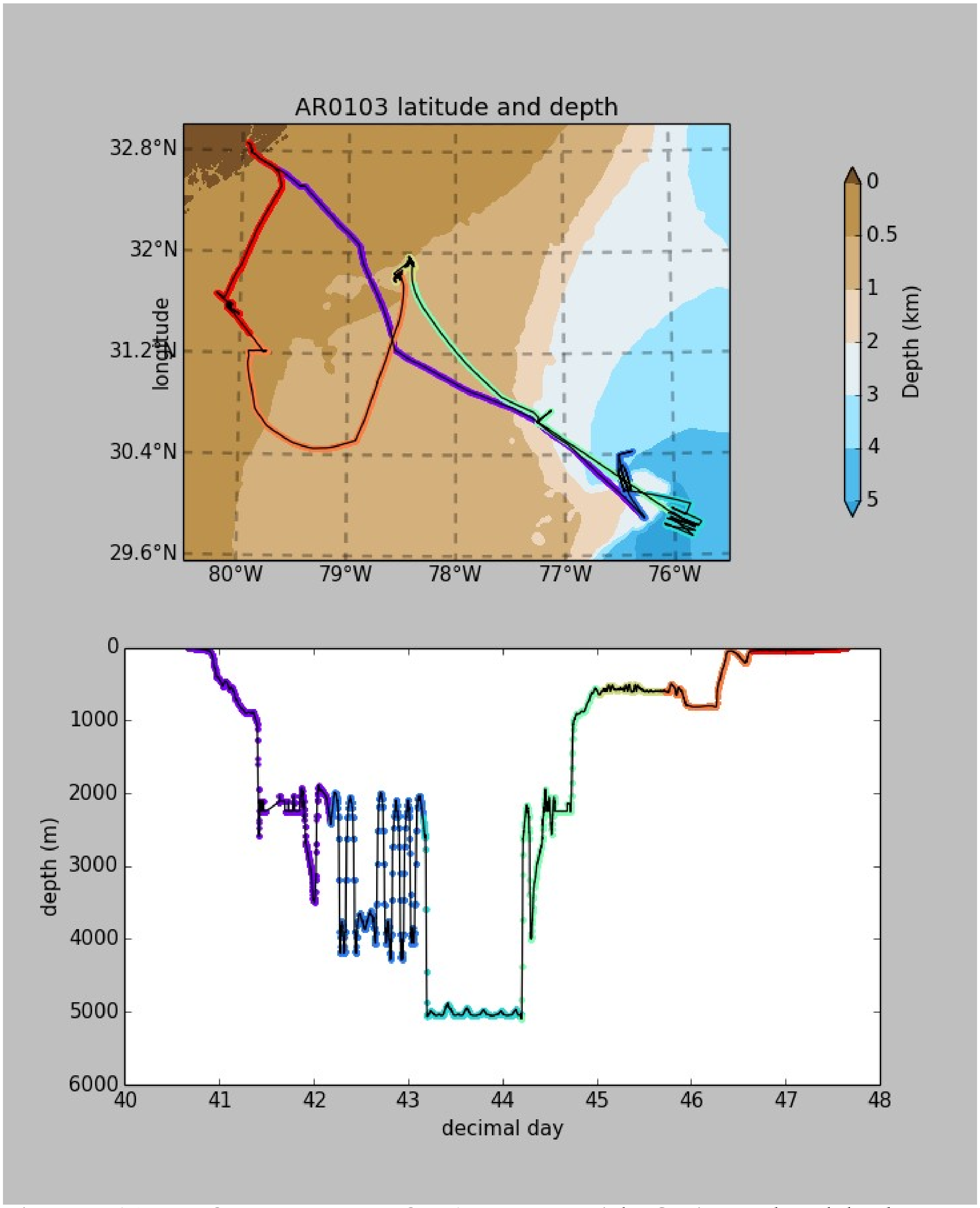

Figure 1: AR0103 Sonar acceptance Sea Acceptance Trials: Cruise track and depths

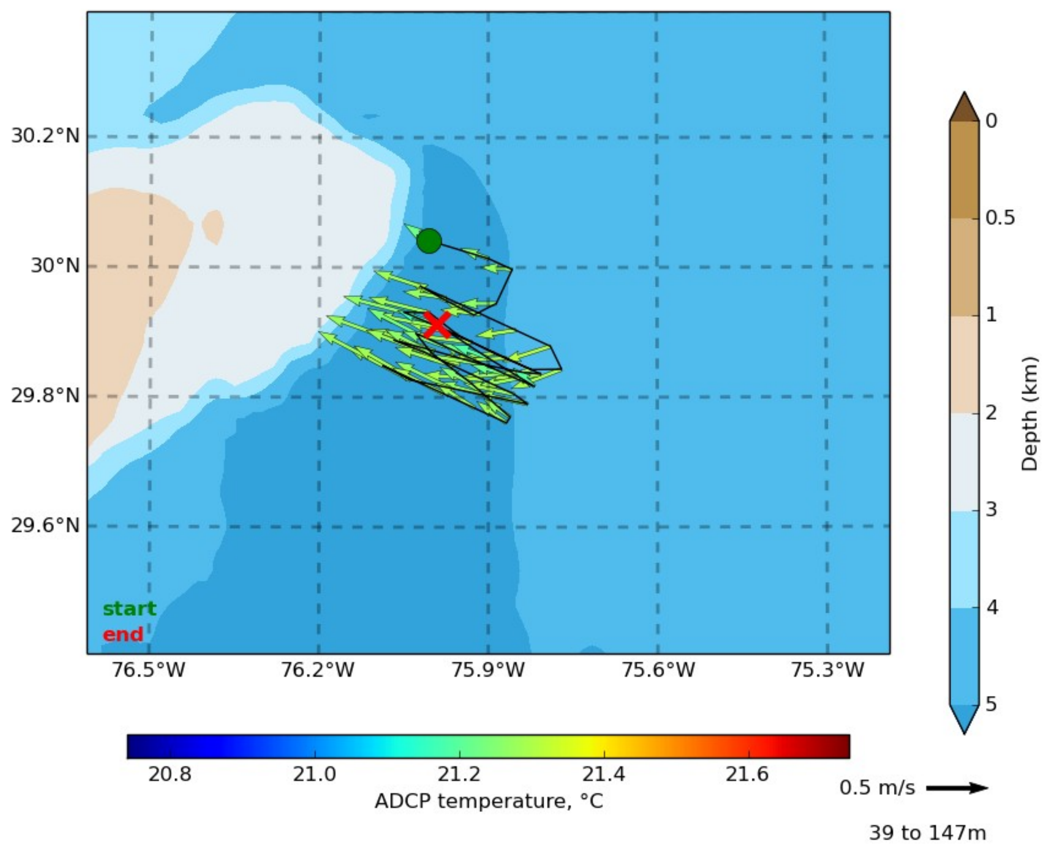

Figure 2: Cruise track during EM122 patch test. Strong currents were coming from the SE, wind and seas from the NW. Transects to the west (northwest) are badly affected by bubbles; transects to the southeast were not badly impacted.

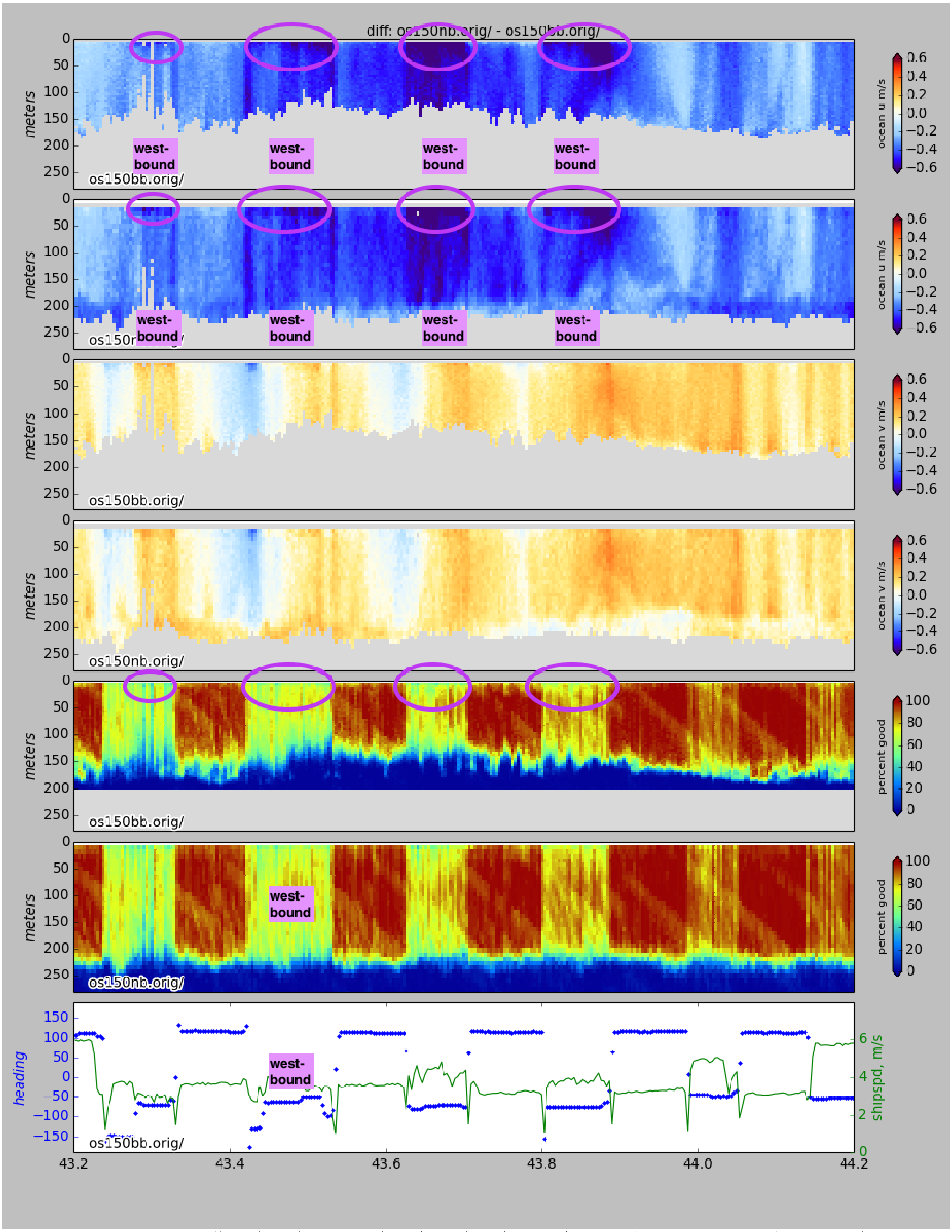

Figure 3: OS150 Broadband and Narrowband modes shown during the EM122 patch test with upwind/downwind transects. Poor data coverage and biases apparent in the west-bound (upwind) sections.

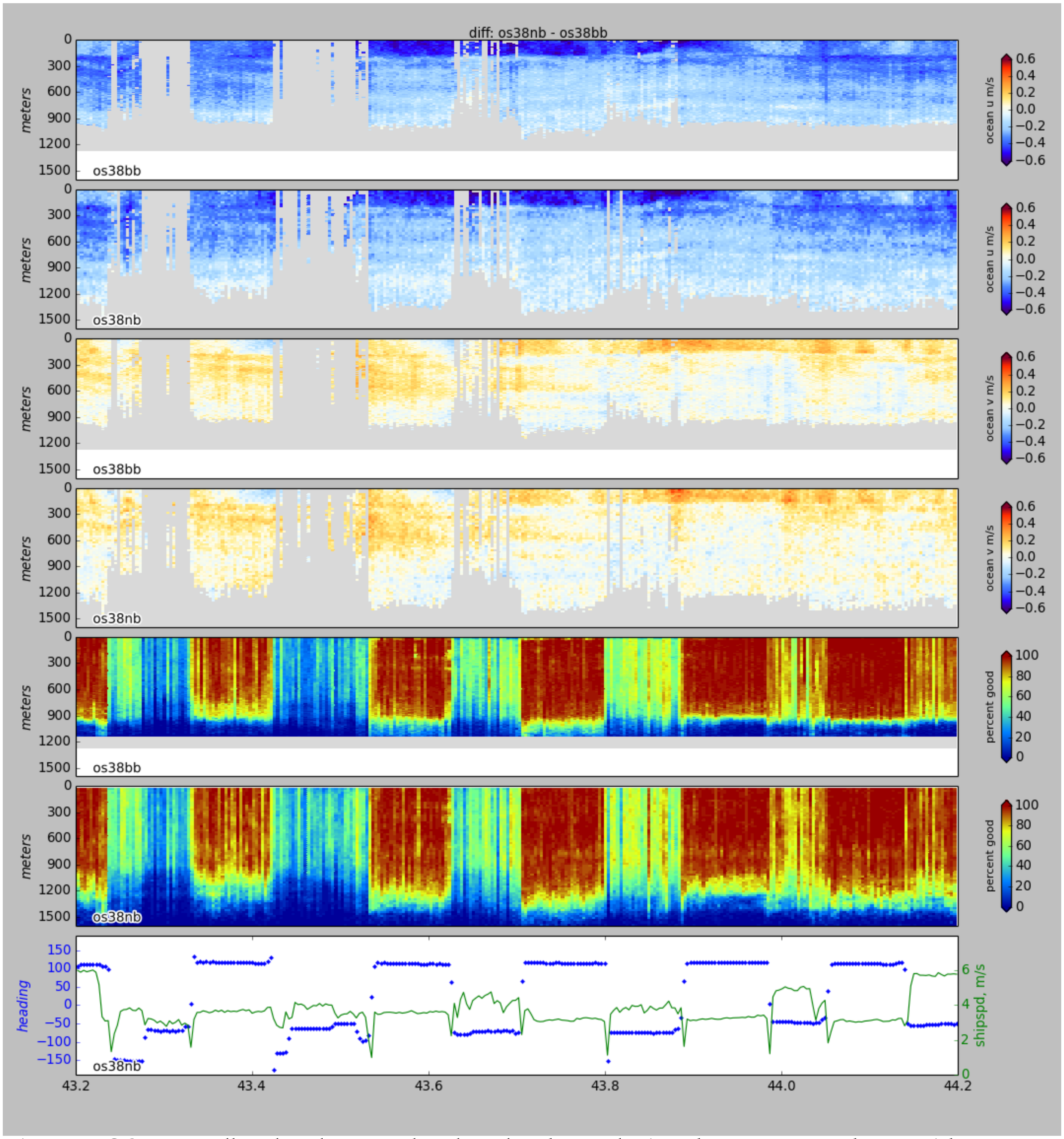

Figure 4: OS38 Broadband and Narrowband modes shown during the EM122 patch test with upwind/downwind transects. Poor data coverage is apparent in the west-bound (upwind) sections. Biases are not as obvious for this instrument, since it seems to simply discard bad data.

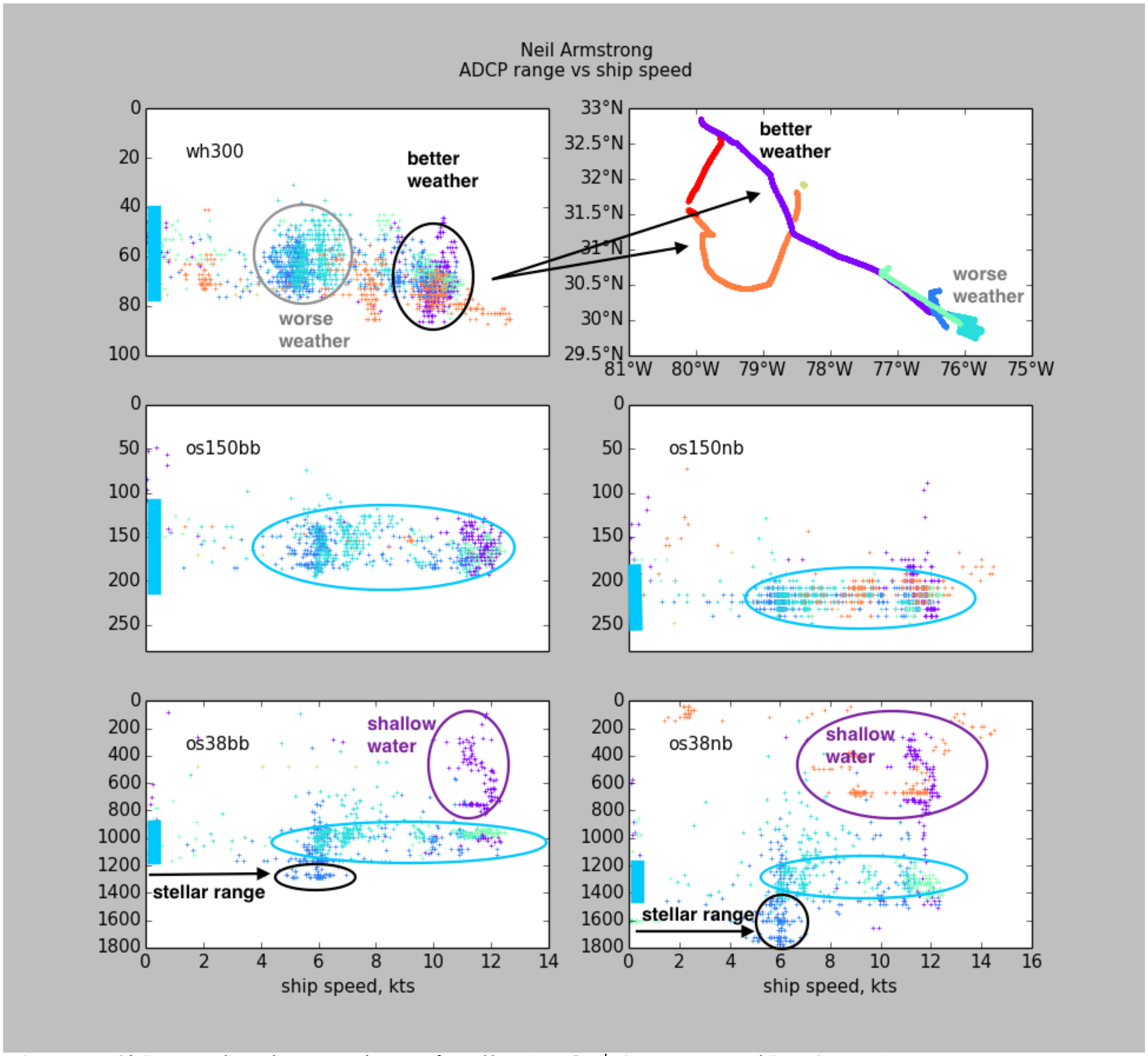

Figure 5: Ship speed and range shown for all 5 ADCP/pingtype combinations. WH300 range was slightly affected by weather and ship speed. OS150 and OS38 ranges were not particulaly affected by ship speed. Note that these data points come from "good" data, after editing, so if bad data had poor range, it is not shown. Typical observed range is shown on the left of each instrument plot as a light blue bar.

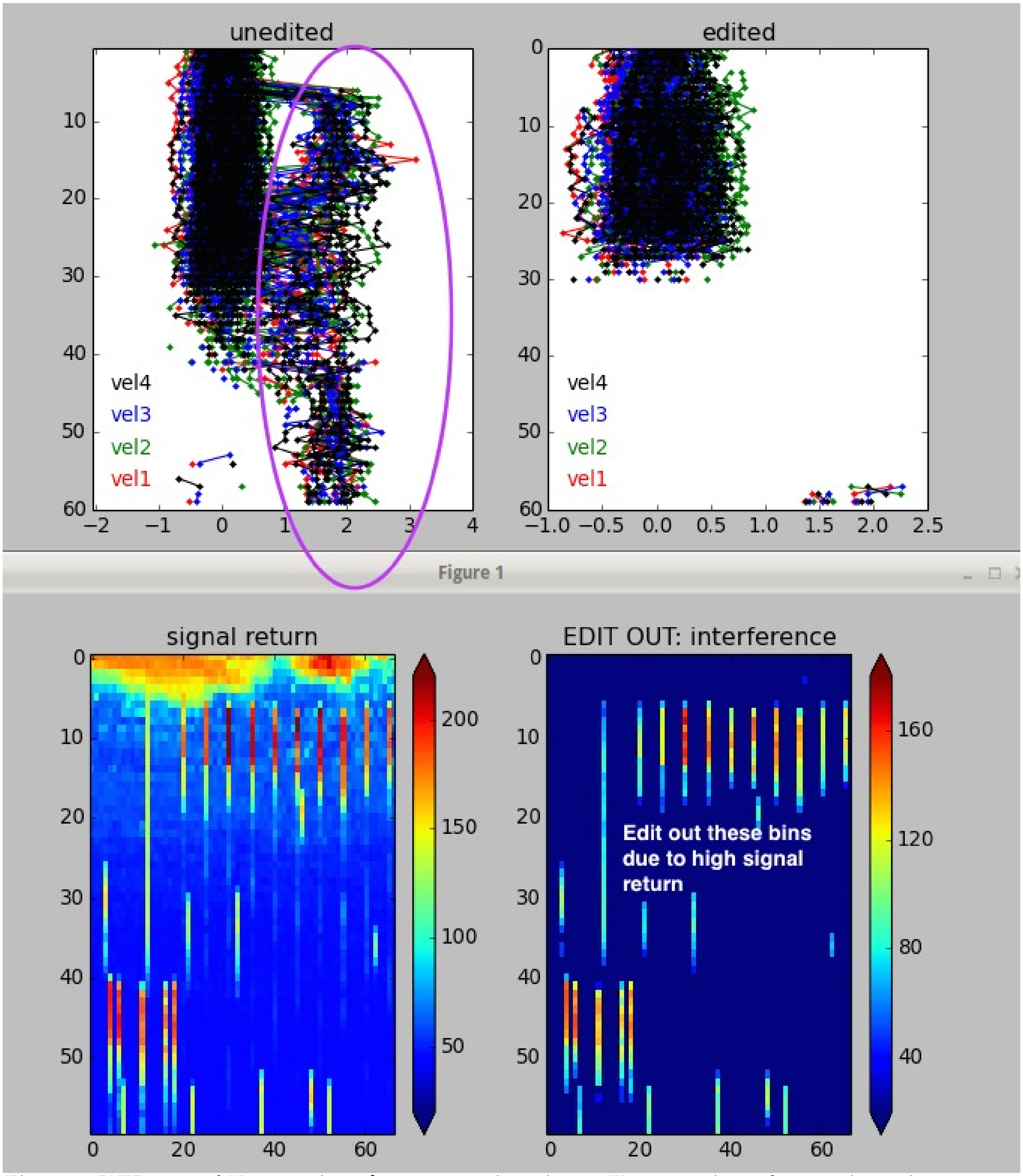

Figure 6: WH300 and Knutsen interference; no triggering so Knutsen pings show up in various parts of the water column. The impact on the beam velocities (top left) is clearly seen. The acoustic interference is the "bright colored stripes" in the lower left. The lower right shows the identification of these bad bins, and the upper right shows the single-ping velocities after the interference is removed.

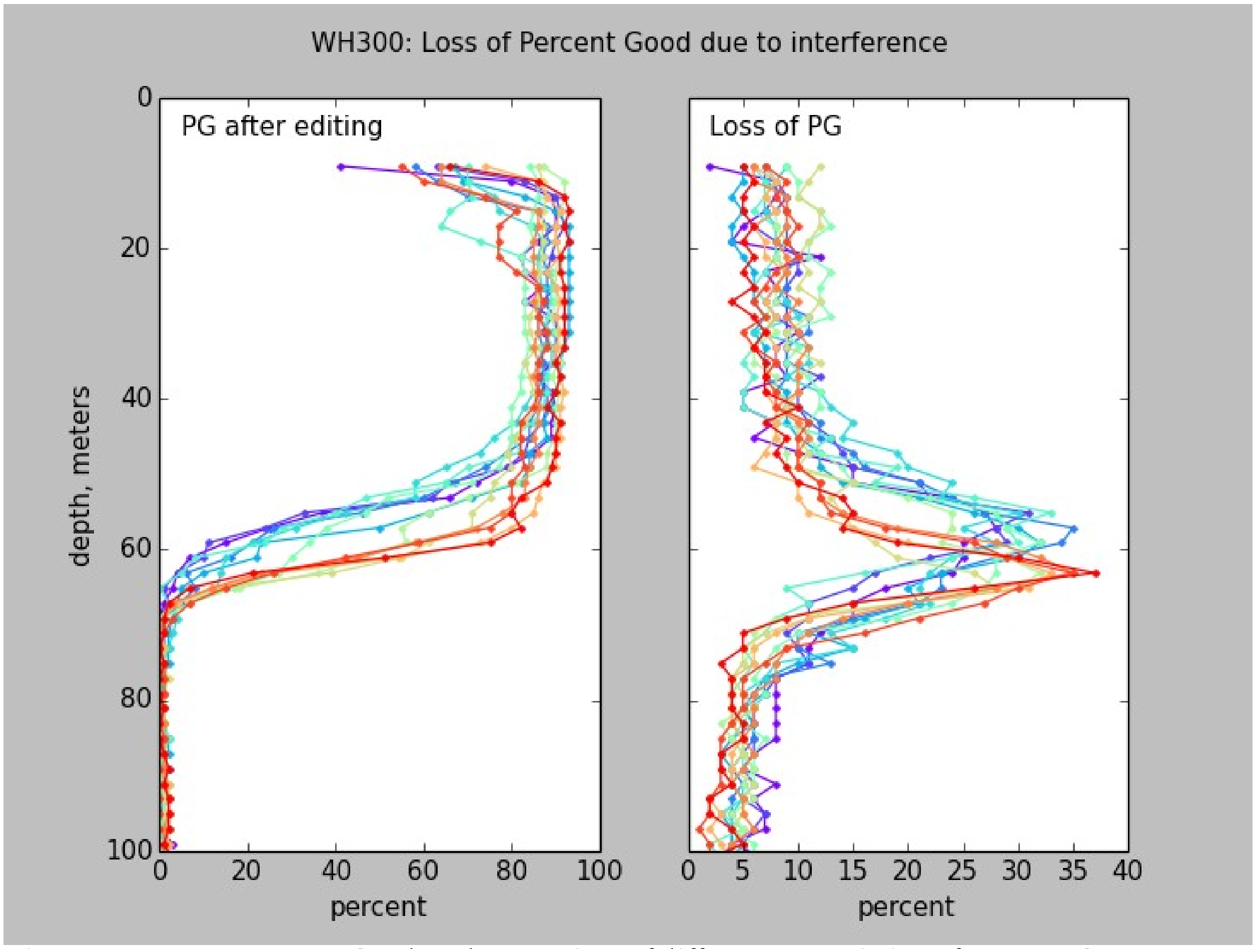

Figure 7: WH300 Percent Good under a variety of different acoustic interference: PG starts at 90 due to existing interference (perhaps the bridge speedlog was not secured?) and decreases further to 80%-90% when additional devices are run.

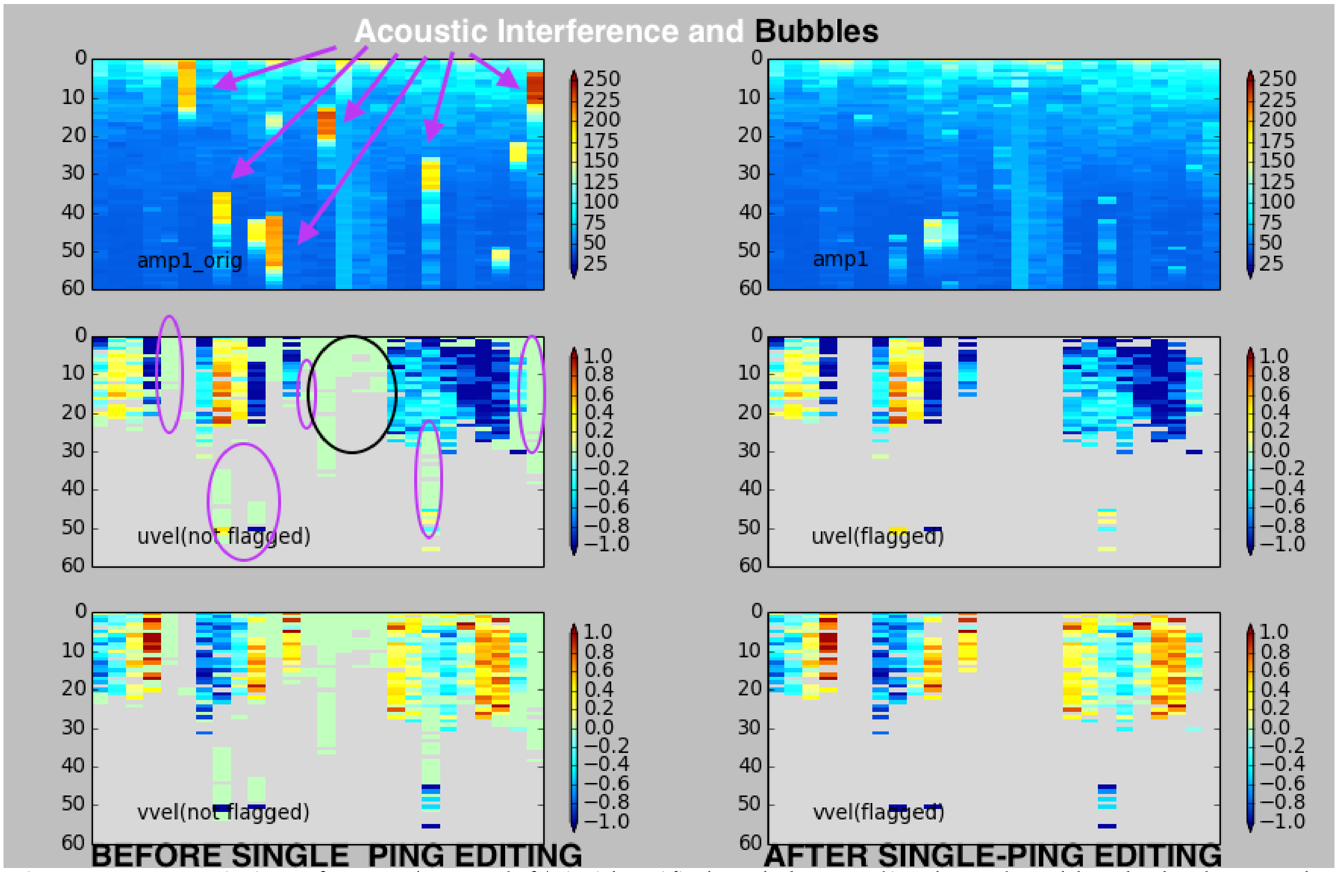

Figure 8: Acoustic interference (upper left) is identified and the amplitude replaced by the background value (upper right). Single-ping velocities (left: middle and lower) are all biased where the interference exists. In addition, short biased profiles exist (due to bubbles) which are unrelated to interference. Biased bins and profiles are removed (right: middle and lower) using the same mask used to identify interference.

5 Appendix

5.1 WH300 HAT (Harbor Acceptance Trial)

```
>PS0
  Instrument S/N:  20767
       Frequency:  307200 HZ
   Configuration:  4 BEAM, JANUS
     Match Layer:  10
      Beam Angle:  20 DEGREES
    Beam Pattern:  CONVEX
     Orientation:  DOWN
       Sensor(s):  HEADING  TILT 1  TILT 2  TEMPERATURE
Temp Sens Offset:  0.13 degrees C

    CPU Firmware:  52.40 [0]
   Boot Code Ver:  Required:  1.16   Actual:  1.16
    DEMOD #1 Ver:  ad48, Type:  1f
    DEMOD #2 Ver:  ad48, Type:  1f
    PWRTIMG  Ver:  85d3, Type:   7

Board Serial Number Data:
   23  00 00 07 89 FE B4  09 PIO727-3000-00G
   0A  00 00 07 89 D5 BC  09 REC727-1000-04E
   C5  00 00 07 89 ED FC  09 DSP727-2001-04H
   B8  00 00 07 89 C5 33  09 CPU727-2011-00E

>PT200

  Ambient  Temperature =    12.46 Degrees C
  Attitude Temperature =    17.34 Degrees C
  Internal Moisture    = 93ECh

Correlation Magnitude: Wide Bandwidth

               Lag  Bm1  Bm2  Bm3  Bm4
                 0  255  255  255  255
                 1  170  164  164  162
                 2   39   27   29   28
                 3   11    8   10   16
                 4   21   25   26   28
                 5   11   16   14    9
                 6    1    4    2    1
                 7    4    3    1    2

  High Gain RSSI:    44   41   41   39
   Low Gain RSSI:    18   15   16   13

  SIN Duty Cycle:    51   49   48   50
  COS Duty Cycle:    51   45   51   48

Receive Test Results = $00000000 ... PASS

IXMT    =      2.9 Amps rms  [Data=ffh]
VXMT    =    151.0 Volts rms [Data=ffh]
   Z    =     51.7 Ohms
Transmit Test Results = $0 ... PASS

    0    0    0    0
    0    0    0    0
    0    0    0    0
    0    0    0    0
  255  255  255  255
    0    0    0    0
```

```
    0    0    0    0
  255  255  255  255
    0    0    0    0
    0    0    0    0
    0    0    0    0
  255  255  255  255
Electronics Test Results = $00000000
Receive Bandwidth:
    Sample      bw    bw    bw    bw    bw
      rate  expect   Bm1   Bm2   Bm3   Bm4
       307     120    91    89    92    92 Khz
   results          PASS  PASS  PASS  PASS
RSSI Time Constant:

RSSI Filter Strobe 1 =   38400 Hz
  time   Bm1   Bm2   Bm3   Bm4
  msec  cnts  cnts  cnts  cnts
     1     8     8     8     8
     2    15    16    15    15
     3    20    22    20    20
     4    26    27    25    26
     5    30    31    29    30
     6    34    35    32    33
     7    37    38    35    36
     8    39    41    37    39
     9    42    44    40    42
    10    44    45    42    44
   nom    54    55    51    53
result    PASS  PASS  PASS  PASS
```

5.2 OS150 HAT (Harbor Acceptance Trial)

```
>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

>PT200
Correlation Magnitude:
........      Lag    Bm1      Bm2      Bm3      Bm4
       0     1.00     1.00     1.00     1.00
       1     0.81     0.81     0.81     0.81
       2     0.41     0.42     0.41     0.42
       3     0.11     0.11     0.10     0.11
       4     0.03     0.03     0.03     0.02
       5     0.02     0.04     0.03     0.03
       6     0.02     0.02     0.02     0.02
       7     0.04     0.00     0.02     0.01

RSSI: 15 18 15 16

PASSED
Receive Bandwidth:
..............................
  Expected     Bm1    Bm2    Bm3    Bm4
  --------    -----  -----  -----  -----
    15500     15118  15015  15078  15105

PASSED
```

5.3 OS38 HAT (Harbor Acceptance Trial)

```
>PS0
       Frequency:  38400 HZ
   Configuration:  4 BEAM, JANUS
 Transducer Type:  ROUND 36x36
  Beamformer Rev:  A02 or later
      Beam Angle:  30 DEGREES
    Beam Pattern:  CONVEX
     Orientation:  DOWN
    CPU Firmware:  23.17
    FPGA Version:  AA
         Sensors:  TEMP

>PT200
Correlation Magnitude:
........      Lag    Bm1      Bm2      Bm3      Bm4
       0     1.00     1.00     1.00     1.00
       1     0.79     0.80     0.80     0.79
       2     0.37     0.40     0.40     0.37
       3     0.08     0.09     0.09     0.06
       4     0.04     0.04     0.04     0.07
       5     0.06     0.05     0.04     0.06
       6     0.03     0.03     0.02     0.02
       7     0.01     0.02     0.01     0.01

RSSI: 15 29 18 15

PASSED
Receive Bandwidth:
..............................
  Expected     Bm1    Bm2    Bm3    Bm4
  --------    -----  -----  -----  -----
     3875      3845   3811   3817   3801

PASSED
```

6 Instrument Settings

6.1 Pingtypes

```
 ================= AR0103_01 ================

------------------- (wh300) --------------
 0  3     40.678595   40.795498    on   (bb, 70, 2.0, 2.0, 2.0)
------------------- (os150) --------------
 0  3     40.678622   40.795492    on   (bb, 80, 4.0, 4.0, 4.0)   (nb, 60, 8.0, 4.0, 8.0)
------------------- (os38) --------------
 0  1     40.763750   40.795414    on   (bb, 80, 12.0, 16.0, 13.2)   (nb, 60, 24.0, 16.0, 24.0)

 ================= AR0103_02 ================

------------------- (wh300) --------------
 0  2     40.796859   40.894210    on   (bb, 70, 2.0, 2.0, 2.0)
------------------- (os150) --------------
 0  2     40.796883   40.894196    on   (bb, 80, 4.0, 4.0, 4.0)   (nb, 60, 8.0, 4.0, 8.0)
------------------- (os38) --------------
 0  2     40.796909   40.894197   off   (bb, 80, 12.0, 16.0, 13.2)   (nb, 60, 24.0, 16.0, 24.0)

 ================= AR0103_03 ================

------------------- (wh300) --------------
 0  3     40.895711   41.013784    on   (bb, 70, 2.0, 2.0, 2.0)
```

```
------------------- (os150) --------------
 0  3     40.895736   41.013778    on   (bb, 80, 4.0, 4.0, 4.0)   (nb, 60, 8.0, 4.0, 8.0)
------------------- (os38) --------------
 0  3     40.895761   41.013743   off   (bb, 80, 12.0, 16.0, 13.2)   (nb, 60, 24.0, 16.0, 24.0)

 ================== AR0103_04 =================

------------------- (wh300) --------------
 0  8     41.015620   41.070751    on   (bb, 70, 2.0, 2.0, 2.0)
------------------- (os150) --------------
 0  4     41.015647   41.028374    on   (bb, 80, 4.0, 4.0, 4.0)   (nb, 60, 8.0, 4.0, 8.0)
 1  1     41.039037   41.042925    on   (nb, 60, 8.0, 4.0, 8.0)
 2  2     41.043771   41.070753   off   (bb, 80, 4.0, 4.0, 4.0)   (nb, 60, 8.0, 4.0, 8.0)
------------------- (os38) --------------
 0  1     41.015669   41.018169   off   (bb, 80, 12.0, 16.0, 13.2)   (nb, 60, 24.0, 16.0, 24.0)
 1  2     41.019086   41.069850   off   (nb, 60, 24.0, 16.0, 24.0)

 ================== AR0103_05 =================

------------------- (wh300) --------------
 0  7     41.072068   41.501966   off   (bb, 70, 2.0, 2.0, 2.0)
------------------- (os150) --------------
 0  7     41.072089   41.501959   off   (bb, 80, 4.0, 4.0, 4.0)   (nb, 60, 8.0, 4.0, 8.0)
------------------- (os38) --------------
 0  7     41.072162   41.501908    on   (bb, 80, 12.0, 16.0, 13.2)   (nb, 60, 24.0, 16.0, 24.0)

 ================== AR0103_06 =================

------------------- (wh300) --------------
------------------- (os150) --------------
------------------- (os38) --------------

 ================== AR0103_07 =================

------------------- (wh300) --------------
 0  5     41.876981   41.934844   off   (bb, 70, 2.0, 2.0, 2.0)
------------------- (os150) --------------
 0  1     41.877003   41.877327   off   (bb, 80, 4.0, 4.0, 4.0)   (nb, 60, 8.0, 4.0, 8.0)
 1  1     41.881333   41.882160   off   (bb, 80, 4.0, 4.0, 4.0)
 2  1     41.882648   41.883704   off   (bb, 10, 4.0, 4.0, 4.0)
 3  1     41.884189   41.886641   off   (nb, 10, 8.0, 4.0, 8.0)
 4  1     41.892281   41.898563   off   (bb, 80, 4.0, 4.0, 4.0)   (nb, 60, 8.0, 4.0, 8.0)
 5  2     41.899270   41.934852   off   (bb, 60, 4.0, 4.0, 4.0)   (nb, 50, 8.0, 4.0, 8.0)
------------------- (os38) --------------
 0  1     41.877041   41.877319   off   (bb, 80, 12.0, 16.0, 13.2)   (nb, 60, 24.0, 16.0, 24.0)
 1  1     41.887478   41.888965   off   (bb, 15, 12.0, 16.0, 13.2)
 2  1     41.889414   41.891513   off   (nb, 15, 24.0, 16.0, 24.0)
 3  1     41.892319   41.898569   off   (bb, 80, 12.0, 16.0, 13.2)   (nb, 60, 24.0, 16.0, 24.0)
 4  2     41.899314   41.934800   off   (bb, 90, 12.0, 16.0, 13.2)   (nb, 70, 24.0, 16.0, 24.0)

 ================== AR0103_08 =================

------------------- (wh300) --------------
 0 18     41.939882   42.566709   off   (bb, 60, 2.0, 2.0, 2.0)
------------------- (os150) --------------
 0 10     41.939900   42.024205   off   (bb, 50, 4.0, 4.0, 4.0)   (nb, 40, 8.0, 4.0, 8.0)
 1  1     42.035024   42.044558   off   (bb, 50, 4.0, 4.0, 4.0)
 2  5     42.181278   42.566701   off   (bb, 50, 4.0, 4.0, 4.0)   (nb, 40, 8.0, 4.0, 8.0)
------------------- (os38) --------------
 0  2     41.949037   41.976449   off   (bb, 95, 12.0, 16.0, 13.2)
 1  2     41.987769   42.015097   off   (nb, 66, 24.0, 16.0, 24.0)
 2  8     42.025686   42.566664   off   (bb, 95, 12.0, 16.0, 13.2)   (nb, 66, 24.0, 16.0, 24.0)

 ================== AR0103_09 =================

------------------- (wh300) --------------
 0  5     42.568356   42.861289   off   (bb, 60, 2.0, 2.0, 2.0)
------------------- (os150) --------------
 0  5     42.568375   42.861284   off   (bb, 50, 4.0, 4.0, 4.0)   (nb, 40, 8.0, 4.0, 8.0)
------------------- (os38) --------------
 0  5     42.568423   42.861266   off   (bb, 105, 12.0, 16.0, 13.2)   (nb, 75, 24.0, 16.0, 24.0)

 ================== AR0103_10 =================

------------------- (wh300) --------------
 0 23     42.862355   44.632439   off   (bb, 60, 2.0, 3.0, 2.0)
------------------- (os150) --------------
 0 23     42.862372   44.632437   off   (bb, 50, 4.0, 6.0, 4.0)   (nb, 40, 8.0, 4.0, 8.0)
------------------- (os38) --------------
 0 23     42.862417   44.632416   off   (bb, 95, 12.0, 16.0, 13.2)   (nb, 66, 24.0, 16.0, 24.0)

 ================== AR0103_11 =================

------------------- (wh300) --------------
```

```
 0 16     44.633431   44.716740   off   (bb, 60, 2.0, 3.0, 2.0)
------------------- (os150) --------------
 0  1     44.681111   44.685463   off   (nb, 40, 8.0, 4.0, 8.0)
 1  1     44.690446   44.694381   off   (bb, 50, 4.0, 6.0, 4.0)
 2  2     44.700344   44.711350   off   (bb, 50, 4.0, 6.0, 4.0)   (nb, 40, 8.0, 4.0, 8.0)
------------------- (os38) --------------
 0  3     44.641012   44.666671   off   (nb, 66, 24.0, 16.0, 24.0)
 1  1     44.671664   44.675761   off   (bb, 95, 12.0, 16.0, 13.2)
 2  2     44.700389   44.711347   off   (bb, 95, 12.0, 16.0, 13.2)   (nb, 66, 24.0, 16.0, 24.0)

 ================== AR0103_12 =================

------------------- (wh300) --------------
 0 29     45.051281   47.642056   off   (bb, 60, 2.0, 3.0, 2.0)
------------------- (os150) --------------
 0  1     45.051292   45.071063   off   (bb, 50, 4.0, 6.0, 4.0)   (nb, 40, 8.0, 4.0, 8.0)
 1 13     45.736660   45.971818   off   (nb, 40, 8.0, 4.0, 8.0)
 2 10     45.972512   46.015014   off   (bb, 50, 4.0, 6.0, 4.0)   (nb, 40, 8.0, 4.0, 8.0)
 3 10     46.015997   46.611646   off   (nb, 40, 8.0, 4.0, 8.0)
 4  1     46.612662   46.623783   off   (bb, 50, 4.0, 6.0, 4.0)   (nb, 40, 8.0, 4.0, 8.0)
 5  3     46.625332   46.832965    on   (nb, 80, 4.0, 4.0, 4.0)
 6  8     46.833848   47.431291   off   (nb, 40, 8.0, 4.0, 8.0)
------------------- (os38) --------------
 0  1     45.051301   45.071057   off   (bb, 95, 12.0, 16.0, 13.2)
 1 14     45.742458   46.127890   off   (nb, 66, 24.0, 16.0, 24.0)
 2  7     46.128703   46.611645   off   (nb, 40, 24.0, 16.0, 24.0)
 3  2     46.833871   46.880144   off   (nb, 66, 24.0, 16.0, 24.0)
```

6.2 Pingtypes and Triggering

```
                                wh300       |              os150           |               os38
                                                                  trigger                            trigger

=====================================================  AR0103_01  =====================================================

2016-02-10 16:15:47,248        StartCruise
2016-02-10 16:16:42,525             WP1    BP1   |     NP1    WP1    BP1    CX0,0   |     NP0    WP0    BP0    CX0,0
2016-02-10 18:18:57,718             WP1    BP1   |     NP1    WP1    BP1    CX0,0   |     NP1    WP1    BP1    CX0,0


=====================================================  AR0103_02  =====================================================

2016-02-10 19:06:22,434        StartCruise
2016-02-10 19:06:46,800             WP1    BP1   |     NP1    WP1    BP1    CX0,0   |     NP1    WP1    BP0    CX0,0


=====================================================  AR0103_03  =====================================================

2016-02-10 21:28:37,839        StartCruise
2016-02-10 21:29:07,189             WP1    BP1   |     NP1    WP1    BP1    CX0,0   |     NP1    WP1    BP0    CX0,0


=====================================================  AR0103_04  =====================================================

2016-02-11 00:21:32,726        StartCruise
2016-02-11 00:21:48,999             WP1    BP1   |     NP1    WP1    BP1    CX0,0   |     NP1    WP1    BP0    CX0,0
2016-02-11 00:26:44,908             WP1    BP1   |     NP1    WP1    BP1    CX0,0   |     NP1    WP0    BP0    CX0,0
2016-02-11 00:31:32,619             WP1    BP1   |     NP1    WP1    BP1    CX0,0   |     NP0    WP0    BP0    CX0,0
2016-02-11 00:38:38,996             WP1    BP1   |     NP1    WP1    BP0    CX0,0   |     NP0    WP0    BP0    CX0,0
2016-02-11 00:41:10,462             WP1    BP1   |     NP0    WP0    BP0    CX0,0   |     NP0    WP0    BP0    CX0,0
2016-02-11 00:55:44,472             WP1    BP0   |     NP1    WP0    BP1    CX0,0   |     NP0    WP0    BP0    CX0,0
2016-02-11 01:02:16,191             WP1    BP0   |     NP1    WP1    BP0    CX0,0   |     NP1    WP0    BP1    CX0,0
2016-02-11 01:41:06,602             WP1    BP0   |     NP1    WP1    BP0    CX0,0   |     NP1    WP1    BP1    CX0,0


=====================================================  AR0103_05  =====================================================

2016-02-11 01:43:03,026        StartCruise
2016-02-11 01:43:05,519             WP1    BP0   |     NP1    WP1    BP0    CX0,0   |     NP1    WP1    BP1    CX0,0
2016-02-11 06:00:05,686             WP1    BP0   |     NP1    WP1    BP0    CX0,0   |     NP1    WP1    BP0    CX0,0


=====================================================  AR0103_07  =====================================================

2016-02-11 21:02:07,869        StartCruise
2016-02-11 21:02:09,645             WP1    BP0   |     NP1    WP1    BP0    CX0,0   |     NP1    WP1    BP0    CX0,0
2016-02-11 21:03:50,679             WP1    BP0   |     NP0    WP0    BP0    CX0,0   |     NP0    WP0    BP0    CX0,0
2016-02-11 21:08:52,681             WP0    BP0   |     NP0    WP1    BP0    CX0,0   |     NP0    WP0    BP0    CX0,0
2016-02-11 21:10:46,634             WP0    BP0   |     NP0    WP1    BP0    CX0,0   |     NP0    WP0    BP0    CX0,0
2016-02-11 21:12:59,350             WP0    BP0   |     NP1    WP0    BP0    CX0,0   |     NP0    WP0    BP0    CX0,0
2016-02-11 21:17:41,303             WP0    BP0   |     NP0    WP0    BP0    CX0,0   |     NP0    WP1    BP0    CX0,0
2016-02-11 21:20:28,210             WP0    BP0   |     NP0    WP0    BP0    CX0,0   |     NP1    WP0    BP0    CX0,0
2016-02-11 21:24:10,312             WP1    BP0   |     NP1    WP1    BP0    CX0,0   |     NP1    WP1    BP0    CX0,0
```

2016-02-11 21:34:14,310		WP1	BP0	NP1	WP1	BP0	CX0,0	NP1	WP1	BP0	CX0,0

=== AR0103_08 ===

2016-02-11 22:31:21,897	StartCruise										
2016-02-11 22:32:59,017		WP1	BP0	NP1	WP1	BP0	CX0,0	NP0	WP0	BP0	CX0,0
2016-02-11 22:45:51,295		WP1	BP0	NP1	WP1	BP0	CX0,0	NP0	WP1	BP0	CX0,0
2016-02-11 22:59:00,662		WP1	BP0	NP1	WP1	BP0	CX0,0	NP0	WP0	BP0	CX0,0
2016-02-11 23:12:45,710		WP1	BP0	NP1	WP1	BP0	CX0,0	NP0	WP1	BP0	CX0,0
2016-02-11 23:26:48,347		WP1	BP0	NP1	WP1	BP0	CX0,0	NP0	WP0	BP0	CX0,0
2016-02-11 23:41:38,699		WP1	BP0	NP1	WP1	BP0	CX0,0	NP1	WP0	BP0	CX0,0
2016-02-11 23:55:18,592		WP1	BP0	NP1	WP1	BP0	CX0,0	NP0	WP0	BP0	CX0,0
2016-02-12 00:08:47,605		WP1	BP0	NP1	WP1	BP0	CX0,0	NP1	WP0	BP0	CX0,0
2016-02-12 00:22:13,738		WP1	BP0	NP1	WP1	BP0	CX0,0	NP0	WP0	BP0	CX0,0
2016-02-12 00:36:27,445		WP1	BP0	NP0	WP0	BP0	CX0,0	NP1	WP1	BP0	CX0,0
2016-02-12 00:49:43,389		WP1	BP0	NP0	WP1	BP0	CX0,0	NP1	WP1	BP0	CX0,0
2016-02-12 01:04:38,149		WP1	BP0	NP0	WP0	BP0	CX0,0	NP1	WP1	BP0	CX0,0
2016-02-12 04:20:20,279		WP1	BP0	NP1	WP1	BP0	CX0,0	NP1	WP1	BP0	CX0,0

=== AR0103_09 ===

2016-02-12 13:37:31,393	StartCruise										
2016-02-12 13:37:45,574		WP1	BP0	NP1	WP1	BP0	CX0,0	NP1	WP1	BP0	CX0,0

=== AR0103_10 ===

2016-02-12 20:41:03,983	StartCruise										
2016-02-12 20:41:06,526		WP1	BP0	NP1	WP1	BP0	CX0,0	NP1	WP1	BP0	CX0,0
2016-02-14 13:13:00,456		WP1	BP0	NP1	WP1	BP0	CX0,0	NP1	WP1	BP0	CX0,0

=== AR0103_11 ===

2016-02-14 15:11:28,815	StartCruise										
2016-02-14 15:11:57,168		WP1	BP0	NP0	WP0	BP0	CX0,0	NP0	WP0	BP0	CX0,0
2016-02-14 15:22:35,726		WP1	BP0	NP0	WP0	BP0	CX0,0	NP1	WP0	BP0	CX0,0
2016-02-14 15:30:02,171		WP1	BP0	NP0	WP0	BP0	CX0,0	NP0	WP0	BP0	CX0,0
2016-02-14 15:38:19,981		WP0	BP0	NP0	WP0	BP0	CX0,0	NP0	WP0	BP0	CX0,0
2016-02-14 15:45:36,754		WP1	BP0	NP0	WP0	BP0	CX0,0	NP0	WP0	BP0	CX0,0
2016-02-14 15:52:26,733		WP0	BP0	NP0	WP0	BP0	CX0,0	NP0	WP0	BP0	CX0,0
2016-02-14 15:53:05,482		WP1	BP0	NP0	WP0	BP0	CX0,0	NP1	WP0	BP0	CX0,0
2016-02-14 16:00:35,374		WP1	BP0	NP0	WP0	BP0	CX0,0	NP0	WP0	BP0	CX0,0
2016-02-14 16:06:42,868		WP1	BP0	NP0	WP0	BP0	CX0,0	NP0	WP1	BP0	CX0,0
2016-02-14 16:13:52,686		WP1	BP0	NP0	WP0	BP0	CX0,0	NP0	WP0	BP0	CX0,0
2016-02-14 16:20:21,837		WP1	BP0	NP1	WP0	BP0	CX0,0	NP0	WP0	BP0	CX0,0
2016-02-14 16:27:43,885		WP1	BP0	NP0	WP0	BP0	CX0,0	NP0	WP0	BP0	CX0,0
2016-02-14 16:33:49,511		WP1	BP0	NP0	WP1	BP0	CX0,0	NP0	WP0	BP0	CX0,0
2016-02-14 16:40:17,160		WP1	BP0	NP0	WP0	BP0	CX0,0	NP0	WP0	BP0	CX0,0
2016-02-14 16:47:46,893		WP1	BP0	NP1	WP1	BP0	CX0,0	NP1	WP1	BP0	CX0,0
2016-02-14 16:56:01,549		WP1	BP1	NP1	WP1	BP1	CX0,0	NP1	WP1	BP1	CX0,0
2016-02-14 17:04:55,800		WP1	BP0	NP0	WP0	BP0	CX0,0	NP0	WP0	BP0	CX0,0

=== AR0103_12 ===

2016-02-14 17:12:50,586	StartCruise										
2016-02-14 20:17:06,583		WP0	BP0	NP0	WP0	BP0	CX0,0	NP0	WP0	BP0	CX0,0
2016-02-15 01:13:11,145		WP1	BP0	NP1	WP1	BP0	CX0,0	NP0	WP1	BP0	CX0,0
2016-02-15 17:40:05,933		WP1	BP0	NP1	WP0	BP0	CX0,0	NP1	WP0	BP0	CX1,1
2016-02-15 17:48:23,888		WP1	BP0	NP1	WP0	BP0	CX0,0	NP1	WP0	BP0	CX0,0
2016-02-15 18:39:55,053		WP1	BP0	NP1	WP0	BP0	CX1,1	NP1	WP0	BP0	CX0,0
2016-02-15 19:07:29,608		WP0	BP0	NP1	WP0	BP0	CX1,2	NP0	WP0	BP0	CX0,0
2016-02-15 19:10:25,497		WP0	BP0	NP1	WP0	BP0	CX1,3	NP0	WP0	BP0	CX0,0
2016-02-15 19:14:06,416		WP0	BP0	NP1	WP0	BP0	CX1,4	NP0	WP0	BP0	CX0,0
2016-02-15 19:19:13,676		WP0	BP0	NP1	WP0	BP0	CX1,1	NP0	WP0	BP0	CX0,0
2016-02-15 19:25:56,643		WP0	BP0	NP1	WP0	BP0	CX1,1	NP1	WP0	BP0	CX1.1
2016-02-15 20:20:13,639		WP0	BP0	NP1	WP0	BP0	CX1,1	NP0	WP0	BP0	CX1,1
2016-02-15 21:04:26,183		WP0	BP0	NP1	WP0	BP0	CX1,1	NP1	WP0	BP0	CX1,1
2016-02-15 21:27:17,157		WP0	BP0	NP1	WP0	BP0	CX1,1	NP0	WP0	BP0	CX1,1
2016-02-15 23:20:09,487		WP0	BP0	NP1	WP1	BP0	CX0,0	NP0	WP0	BP0	CX1,1
2016-02-15 23:27:45,751		WP0	BP0	NP1	WP1	BP0	CX1,1	NP0	WP0	BP0	CX1,1
2016-02-15 23:42:25,216		WP0	BP0	NP1	WP1	BP0	CX1,1	NP1	WP0	BP0	CX1,1
2016-02-15 23:43:37,427		WP0	BP0	NP1	WP1	BP0	CX1,1	NP1	WP0	BP0	CX0,0
2016-02-15 23:51:12,329		WP0	BP0	NP1	WP1	BP0	CX0,0	NP1	WP0	BP0	CX0,0
2016-02-15 23:57:37,961		WP0	BP0	NP1	WP1	BP0	CX1,1	NP1	WP0	BP0	CX0,0
2016-02-16 00:04:44,805		WP0	BP0	NP1	WP1	BP0	CX0,0	NP1	WP0	BP0	CX0,0
2016-02-16 00:11:12,373		WP0	BP0	NP1	WP1	BP0	CX0,0	NP1	WP0	BP0	CX1,1
2016-02-16 00:12:30,202		WP0	BP0	NP1	WP1	BP0	CX1,1	NP1	WP0	BP0	CX0,0
2016-02-16 00:21:59,908		WP0	BP0	NP1	WP0	BP0	CX1,1	NP1	WP0	BP0	CX0,0
2016-02-16 00:44:31,465		WP1	BP0	NP1	WP0	BP0	CX0,0	NP1	WP0	BP0	CX0,0
2016-02-16 03:04:38,831		WP1	BP0	NP1	WP0	BP0	CX0,0	NP1	WP0	BP0	CX0,0
2016-02-16 14:41:45,273		WP1	BP0	NP1	WP1	BP0	CX0,0	NP0	WP0	BP0	CX0,0
2016-02-16 15:00:02,604		WP1	BP1	NP1	WP0	BP1	CX0,0	NP0	WP0	BP0	CX0,0
2016-02-16 20:00:01,098		WP1	BP1	NP1	WP0	BP0	CX0,0	NP1	WP0	BP0	CX0,0
2016-02-16 20:59:38,436		WP1	BP1	NP1	WP0	BP0	CX0,0	NP1	WP0	BP0	CX0,0
2016-02-16 21:07:45,080		WP1	BP1	NP1	WP0	BP1	CX0,0	NP0	WP0	BP0	CX0,0
2016-02-17 04:37:48,780		WP1	BP1	NP1	WP0	BP1	CX0,0	NP0	WP0	BP0	CX0,0
2016-02-17 10:21:24,262		WP1	BP0	NP0	WP0	BP0	CX0,0	NP0	WP0	BP0	CX0,0

6.3 Interference Tests

AR0103_08   2016/02/11 to 2016/02/12
purpose: determine the effect of OS38BB and OS38NB on WH300 and OS150
comment: should have done this with WH300 only, and os150 only
but the answer is: CODAS single-ping editing is sufficient

ON	OFF	WH300	OS150BB	OS150NB	OS38BB	OS38NB
22:33:25	22:45:21	x	x	x	-	-
22:46:36	22:58:39	x	x	x	x	-
22:59:28	23:12:18	x	x	x	-	-
23:13:29	23:26:21	x	x	x	x	-
23:27:15	23:40:52	x	x	x	-	-
23:42:22	23:54:55	x	x	x	-	x
23:55:46	00:08:09	x	x	x	-	-
00:09:31	00:21:59	x	x	x	-	x
00:22:40	00:35:00	x	x	x	-	-

x = on
- = off

```
ddranges=[
 (41.939872,  41.948159)
 (41.949027,  41.957395)
 (41.957962,  41.966875)
 (41.967696,  41.976631)
 (41.977256,  41.986712)
 (41.987754,  41.996469)
 (41.997060,  41.005659)
 (42.006608,  42.015266)
 (42.015740,  42.024305)
  ]
```

AR0103_11   2016/02/14   EM710 listening passively
purpose: What is the effect of OS150 and OS38 on WH300
comment: poor thing is hammered by all pings

ON	OFF	WH300	OS150BB	OS150NB	OS38BB	OS38NB
15:38:32	15:47:07	-	-	-	-	-
15:45:49	15:52:00	x	-	-	-	-
15:53:32	16:00:14	x	-	-	-	x
16:00:52	16:06:13	x	-	-	-	-
16:07:12	16:13:22	x	-	-	x	-
16:14:05	16:19:48	x	-	-	-	-
16:20:49	16:27:23	x	-	x	-	-
16:27:56	16:33:20	x	-	-	-	-
16:34:16	16:39:54	x	x	-	-	-
16:40:29	16:47:00	x	-	-	-	-
16:48:13	16:55:22	x	x	x	x	x
16:56:25	17:04:35	x	x	x	x	x plus all BT
17:05:06	17:12:13	x	-	-	-	-

x = on
- = off

```
ddranges=[
 (44.651756, 44.6577199),
 (44.656813, 44.6611111),
 (44.662173, 44.6668287),
 (44.667262, 44.6709837),
 (44.671667, 44.6759490),
 (44.676446, 44.6804166),
```

```
 (44.681129, 44.6856828),
 (44.686061, 44.6898148),
 (44.690466, 44.6943755),
 (44.694785, 44.6993055),
 (44.700157, 44.7051157),
 (44.705841, 44.7115162),
 (44.71187 , 44.7168171),
]
```

AR0103_12 2016/02/15-16 ADCP OS150 trigger tests
Purpose: running OS150, compare effect with and without triggering
Comment: WH300 and OS38 were secured but apparently not all sonars were

ON	trig	notrig	mode	EM710	EK80	Knutsen
23:28:03	-	x	bb/nb	-	-	-
23:44:--	x	-	bb/nb	x	-	-
23:51:--	-	x	bb/nb	-	-	-
23:57:41	x	-	bb/nb	-	x	-
00:05:17	-	x	bb/nb	-	-	-
00:12:44	x	-	bb/nb	-	-	x
00:22:31	x	-	nb	-	-	x

x = on
- = off

```
ddranges=[
[ 45.97781 ,   45.98888],
[ 45.98888 ,   45.99375],
[ 45.99375 ,   45.99839],
[ 45.99839 ,   46.00366],
[ 46.00366 ,   46.00884],
[ 46.00884 ,   46.01563],
[ 46.01563 ,   46.01910],
```