Cruise Report: Shipboard ADCP measurements CLIVAR/Carbon PO2E 2013

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Personnel

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System description

The *R/V Melville* normally has two Acoustic Doppler Current Profilers (ADCPs) mounted in instrument wells in the hull. One, a 150 kHz Teledyne RD Instruments Ocean Surveyor, was at the manufacturer for repair so was unavailable for the cruise. The other, a 75 kHz Ocean Surveyor (OS75) was present and produced data through the entire cruise.

An additional ADCP, a 300 kHz Work Horse (WH300, also from Teledyne RD), was installed temporarily while the ship was in Yokohama before P02W. it was mounted in the open instrument well on a pipe string at about 2.5 feet below the hull. Approximate locations of the ADCPs are shown in Figure 1. The WH300 installation is shown in Figure 2.

Because ship speeds are much faster than typical ocean currents, precise knowledge of the speed and orientation of the ship is required to calculate currents from the raw data. To this end, the ADCP data acquisition system gathered data from 4 additional devices: a Furuno GP-150 GPS for position, a Sperry MK 37 gyro for reliable but coarse heading, and two GPS-assisted attitude sensors for high-precision heading, an Ashtech ADU and a CodaOctopus F185 motion reference unit. The Ashtech heading was inoperative for the entire cruise, so we had to rely on the CodaOctopus, which performed well most of the time.

Data acquisition from the ADCPs and the other devices was done using UHDAS (University of Hawaii Data Acquisition System), an open source software system developed by the ADCP group at UH. It automatically updates a website on the ship's network that presents near real time plots of current depth profiles, contoured sections for the previous few days, and provides a variety of data products ranging from raw data to near-final currents. For extensive documentation about UHDAS, visit the UH ADCP web page, `http://currents.soest.hawaii.edu`.

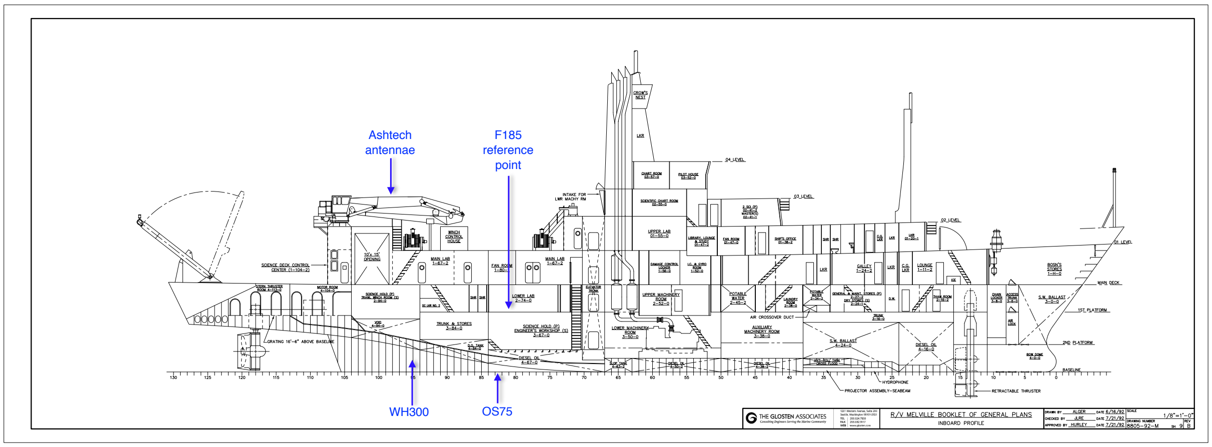

Figure 1: Locations of shipboard ADCPs on the *Melville* during P02W and P02E. Also shown are the two GPS-referenced heading device reference locations. The GP-150 GPS antenna is located in the mast above the stacks.

Figure 2: The WH300 mounted on the pipe string. The picture was taken on the port side looking forward from near the position of the stern thruster. Photo by Drew Cole, who used a pole-mounted GoPro Hero 300 videocamera.

While the output of UHDAS is suitable for shipboard use, it is by no means a final product as some manual intervention is inevitably necessary to deal with issues that arise. The data produced during the cruise must be regarded as preliminary; fully processed data will be made available within 6 months at the UH website.

Operating parameters

Both the OS75 and WH300 were operated in their default UHDAS configurations through the entire cruise except for the first few hours out of Honolulu when both instruments were run with bottom track mode turned on.

The OS75 (CPU firmware 23.16, beam angle 30°) can operate in two modes. Narrow band pings provide greater range, while broadband pings have much better accuracy. The OS75 was operated in interleaved mode, which alternates broadband and narrowband pings. Bottom track mode was used for the first few hours while leaving Honolulu. Narrowband mode used nominal 16 m pings and depth ranges below an 8 m blanking interval, while the broadband mode used 8 m cells and blanking intervals. Pings were 1.8 s apart.

The WH300 (serial number 9806, firmware version 16.28, beam angle 20°) used 2 m cells and blanking intervals with 0.8 s between pings.

The following control files do not contain the entire set of commands sent to the instrument, but these are the ones most frequently changed.

OS75 control file

```
# Bottom tracking
BP0          # BP0 is off, BP1 is on
BX10000      # Max search range in decimeters; e.g. BX10000 for 1000 m.

# Narrowband watertrack
NP1          # NP0 is off, NP1 is on
NN60         # number of cells
NS1600       # cell size in centimeters; e.g. NS2400 for 24-m cells
NF800        # blanking in centimeters; e.g. NF1600 for 16-m cells

# Broadband watertrack
WP1          # WP0 is off, WP1 is on
WN80         # number of cells
WS800        # cell size in centimeters
WF800        # blanking in centimeters

# Interval between pings
TP00:01.80   # e.g., TP00:03.00 for 3 seconds

# Triggering
CX0,0        # in,out[,timeout]
```

WH300 control file

```
BP0           #  Bottom track on (BP1) or off (BP0)
BX2000        #  BT max search range in decimeters (BX02000 for 200 m)
WN70          #  number of cells
WS200         #  cell size in centimeters
WF200         #  blanking in centimeters
TP00:00.80    #  ping interval; TP00:00.80 is 0.8 seconds
```

Data gathered

Both instruments ran continuously and produced data throughout the cruise. On station, all of the instruments generally worked very well. The WH300 profiled to 80 m or so while the OS75 broadband and narrowband modes generally reached 650 and 850 m, respectively.

Problems encountered

Steaming increases acoustic noise and vibration, reducing ADCP range. The WH300 was particularly affected, becoming nearly useless during transits between stations. It is not clear why it had such problems, but a review of a couple of earlier *Melville* cruises with nearly identical WH300 installations revealed similar problems. Bubbles can wreak havoc by scattering the beams, but the WH position well aft and 2.5 feet below the hull makes that seem unlikely. I looked down the instrument well several times, but there appeared to be few, if any, bubbles coming up. The most likely explanation is vibration, but we have no direct evidence of that. It may be that fairing the pipe or the instrument itself could help.

Poor data quality combined with only a preliminary calibration of installation angle meant that what little current data could be retrieved was obviously flawed, with large along-track biases. It may be possible to clean up some of the transit data during postprocessing, but the WH300 data should probably only be used on station.

The OS75 suffered much less during transit. Narrowband mode still exceeded 600 m while broadband sometimes had trouble below 200 m but usually managed 500 m. I understand from the First Mate, David Cook, that the *Melville* is typically ballasted so the bow rides a bit low, reducing bubble noise during transit. We appreciate this attention to our needs, and it evidently works.

While the weather was fine for most of P02E, there were a couple of episodes with high winds and significant seas. Unlike P02W, the OS75 was never overwhelmed by bubbles, though its range was occasionally reduced to about 500 m in narrow band mode.

We were surprised to note occasional problems with the OS75 on station during very calm weather. There would be short periods, usually a minute or less, where the signal strength would drop to near zero. Unlike P02W, I never observed this to last more than a minute or so. At the moment, our best guess is that bubbles filled the instrument well, disrupting the instrument's contact with the water. The OS75 well is blind–there is no way for bubbles to exit out the top. The OS150 installation on the *Melville* suffered badly from this in previous years, so a similar situation for the OS75 is plausible. If this is really the problem, it requires venting the top of the well. The weak beam problem resolved as soon as the ship started moving. Since these gaps in the data were always short, they will have little effect on the final dataset.

As noted above, with the Ashtech ADU heading mode unusable, UHDAS relied exclusively on the CodaOctopus F185 for precision heading. The Ashtech had been the default. At the beginning of P02E, the UHDAS configuration was changed to use the F185 as the primary precision heading device. The precise alignment between the F185 and the OS75 was unknown, so a proper heading correction could not be applied. The alignment difference appears to be about 0.3°, which introduced errors that will not be corrected until final processing.

When the ship is turning, there is a velocity difference between the ADCP and the GPS unless the GPS is co-located with the ADCP. CODAS processing can correct for this velocity difference. The reference point of the CodaOctopus 185 is in the lower lab, within 4 m or so of the ADCP location. This is much closer that the Ashtech antenna locations (Figure 1), so a minor correction will be needed in the final processing.

On May 26, Mary Johnson noticed problems with the EM122 multibeam that were traced to the F185, which had lost its bearings. Frank Delahoyde cycled the power, and it re-established heading and attitude. The data were bad from roughly 0640 to 0855 UTC. The Sperry gyro feed did continue, so current data from that period will be produced during post-processing, although with greater errors than usual.