Part I: ADCP

- Getting Ocean Velocity
- ADCP Acquisition Systems: UHDAS, VmDAS
- What can go wrong

Part II: UHDAS
NOAA Newport 2012 ADCP

Part II: UHDAS

- ADCP Processing with CODAS
- UHDAS: What it does
- Monitoring
  - At sea
  - On Land
- What can be changed, tested
Part I: ADCP

- Getting Ocean Velocity
- ADCP Acquisition Systems: UHDAS, VmDAS
- What can go wrong
(I) ADCP: Getting Ocean Velocity

**ADCP:**

**Acoustic** (it pings along beams at a frequency)

**Doppler** (uses frequency shift to get velocity along the beam)

**Current** (include many more steps to get ocean velocity)

**Profiler** (listen for the return in small chunks of time to create a vertical profile)
(I) ADCP: Getting Ocean Velocity

ADCP : Acoustic

\[ \text{sound speed} = \text{frequency} \times \text{wavelength} \]

(ocean) (instrument)
ADCP: Acoustic Doppler

incoming wavelength longer

incoming wavelength shorter

lower frequency

higher frequency

\[
\text{sound speed} = \text{frequency} \times \text{wavelength}
\]

(ocean) (instrument)
“Gating” the return over time results in “bins” in the vertical, creating a profile of information.
ADCP: Getting Ocean Currents
ADCP: Getting Ocean Currents

9: ADCP-- Current (2)
ADCP
Getting Ocean Currents

Four beams
- 90deg apart
- 30 (or 20)deg up from vertical
- “forward beam” is #3
- usually 45deg starboard of forward
ADCP
Getting Ocean Currents

Four beams
• 90deg apart
• 30 (or 20)deg up from vertical
• “forward beam” is #3
• usually 45deg starboard of forward
ADCP
Getting Ocean Currents

Two opposite beams make a vertical plane
ADCP
Getting Ocean Currents

Now we have two vertical planes at 90deg to each other.

These are the basis of the horizontal and vertical velocities.

Horizontal velocities will be used to get ocean velocities.

Vertical velocities will be used for error-checking.
ADCP
Getting Ocean Currents

Two beams make one vertical plan

This shows the velocities determined by the Doppler shift

“beam velocities”
ADCP: Getting Ocean Currents

Interpret the two beam velocities: one horizontal and one vertical velocity.
ADCP:
Getting Ocean Currents

Now we see the horizontal and vertical velocities on the two planes.

Use the horizontal velocities for determining ocean velocities requires more steps.
ADCP:
Getting Ocean Currents

This is a top-down view of the measured horizontal velocity in instrument coordinates (from the two planes made by the beams) (determining ocean velocities requires more steps)
ADCP: Getting Ocean Currents

This is a top-down view of the measured horizontal velocity in ship coordinates.

The instrument coordinates values are rotated by the transducer angle.

(determining ocean velocities requires more steps)
ADCP: Getting Ocean Currents

This is a top-down view of the measured horizontal velocity in earth coordinates.

The instrument coordinates values are rotated by the ship's heading.

(determining ocean velocities requires more steps)
ADCP: Getting Ocean Currents

Summary of steps:

Doppler to beam (not shown)
below here: horizontal + vertical

• beam to instrument
• instrument to ship
• ship to earth

beam coordinates

+ geometry

instrument coordinates:
2 horizontal, 1 vertical, 1 quality indicator
+ transducer orientation

ship coordinates
+ heading

earth coordinates
measured velocity: east, north, up, error
ADCP: Getting Ocean Currents

Earth coordinates + GPS gives ship speed

add ship speed to measured velocity to get ocean velocity

If no ocean currents:

\[ U_{\text{meas}} = -U_{\text{ship}} \]

With Ocean current:

\[ U_{\text{meas}} = -U_{\text{ship}} + U_{\text{ocean}} \]

\[ U_{\text{meas}} + U_{\text{ship}} = U_{\text{ocean}} \]
ADCP: Getting Ocean Currents

Complete summary:

beam velocities +
transducer orientation + heading +
gps +
ocean velocities

Earth coordinates

With Ocean current

\[ U_{\text{meas}} = -U_{\text{ship}} + U_{\text{ocean}} \]

\[ U_{\text{meas}} + U_{\text{ship}} = U_{\text{ocean}} \]

beam velocities
geometry
transducer orientation
heading +
gps

= \( U_{\text{ocean}} \)
Part I: ADCP

- Getting Ocean Velocity
- ADCP Acquisition Systems: UHDAS, VmDAS
- What can go wrong
ADCP Acquisition systems

- Basic requirements:
  - Control ADCP settings
  - Acquire ADCP data
  - Acquire ancillary data
    - Position
    - Attitude (heading)
  - Timestamp all

- Processing

- Monitoring

Core

Extra

24: Acquisition Systems (1)
ADCP Acquisition systems

- Basic requirements
- Processing
  - Coordinate transformation
  - Editing
  - Averaging
  - Graphical Displays
- Monitoring
ADCP Acquisition systems

- Basic requirements
- Processing
- Monitoring
  - Computer system
  - Data acquisition
  - Processing
  - Access to data

26: Acquisition Systems (3)
ADCP Acquisition systems

- Basic requirements
  - Overview
  - Serial setup
  - Data logging
- Processing
- Monitoring
# ADCP Acquisition Systems - Overview

<table>
<thead>
<tr>
<th></th>
<th>UHDAS</th>
<th>VmDAS</th>
</tr>
</thead>
<tbody>
<tr>
<td>developer</td>
<td>Univ Hawaii</td>
<td>TRDI</td>
</tr>
<tr>
<td>style</td>
<td>linux system</td>
<td>windows application</td>
</tr>
<tr>
<td>source</td>
<td>open source</td>
<td>executable</td>
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<td>purpose</td>
<td>seagoing oceanographers</td>
<td>all-purpose</td>
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<tr>
<td>goals</td>
<td>maximize usefulness at sea</td>
<td>off-the-shelf</td>
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<td></td>
<td>maximize usefulness at sea</td>
<td></td>
</tr>
<tr>
<td></td>
<td>long-term value for research</td>
<td></td>
</tr>
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<td>evolution</td>
<td>continuous</td>
<td>incremental</td>
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<tr>
<td>setup</td>
<td>complex</td>
<td>confusing</td>
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</table>
### Acquisition: Serial Setup

<table>
<thead>
<tr>
<th>ADCPs Feeds Messages</th>
<th>UHDAS</th>
<th>VmDAS</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADCPs</td>
<td>multiple</td>
<td>one (per instance)</td>
</tr>
<tr>
<td>feeds</td>
<td>any number</td>
<td>3 (older version=2)</td>
</tr>
<tr>
<td>messages</td>
<td>many types</td>
<td>fewer types</td>
</tr>
<tr>
<td></td>
<td>can add more</td>
<td></td>
</tr>
<tr>
<td></td>
<td>subsample feed</td>
<td></td>
</tr>
<tr>
<td></td>
<td>choose messages</td>
<td></td>
</tr>
<tr>
<td>gui controls</td>
<td>instrument settings</td>
<td>everything</td>
</tr>
<tr>
<td>operation</td>
<td>simple</td>
<td>simple/confusing</td>
</tr>
<tr>
<td>protected</td>
<td>serial</td>
<td>nothing protected</td>
</tr>
</tbody>
</table>

29: Acquisition Systems – Basic requirements (3)
# Acquisition: Data Logging

<table>
<thead>
<tr>
<th></th>
<th>UHDAS</th>
<th>VmDAS</th>
</tr>
</thead>
<tbody>
<tr>
<td>data logging</td>
<td>separate processes</td>
<td>one big program</td>
</tr>
<tr>
<td>time tagging</td>
<td>buffered tag every line</td>
<td>unbuffered tag ensemble</td>
</tr>
<tr>
<td>data formats</td>
<td>multiple</td>
<td>TRDI ADCP</td>
</tr>
<tr>
<td>data directory</td>
<td>heirarchical</td>
<td>flat</td>
</tr>
<tr>
<td>time range</td>
<td>match per file</td>
<td>match for one logging period</td>
</tr>
<tr>
<td>filenames sort</td>
<td>always</td>
<td>one logging period</td>
</tr>
<tr>
<td>(time=ascii)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>metadata</td>
<td>stored with data</td>
<td>ascii files elsewhere</td>
</tr>
</tbody>
</table>

30: Acquisition Systems – Basic requirements (4)
ADCP Acquisition systems

- Basic requirements
  - Overview
  - Serial setup
  - Data logging

- Processing
  - Processing components
  - Accessing data products

- Monitoring
# Processing

<table>
<thead>
<tr>
<th></th>
<th>UHDAS</th>
<th>VmDAS</th>
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</thead>
<tbody>
<tr>
<td>editing</td>
<td>CODAS</td>
<td>minimal</td>
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<tr>
<td>heading</td>
<td>reliable</td>
<td>primary</td>
</tr>
<tr>
<td>secondary</td>
<td>corrected to</td>
<td>replaced by</td>
</tr>
<tr>
<td>heading</td>
<td>accurate</td>
<td>fallback</td>
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<tr>
<td>pings</td>
<td>interleaved</td>
<td>first</td>
</tr>
<tr>
<td>configure</td>
<td>no</td>
<td>yes</td>
</tr>
<tr>
<td>plots??</td>
<td>oceanographic:</td>
<td>profile (speed, dir)</td>
</tr>
<tr>
<td></td>
<td>- profiles (E,N)</td>
<td>vector</td>
</tr>
<tr>
<td></td>
<td>- vector (+topo)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- contour</td>
<td>WinADCP?</td>
</tr>
<tr>
<td></td>
<td>- bridge (mariner)</td>
<td></td>
</tr>
<tr>
<td>Accessing Data Products</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-------------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>UHDAS</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>VmDAS</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>access plots</td>
<td>ship's web</td>
<td>console only</td>
</tr>
<tr>
<td></td>
<td>console</td>
<td></td>
</tr>
<tr>
<td>data formats</td>
<td>TRDI</td>
<td>TRDI</td>
</tr>
<tr>
<td></td>
<td>Matlab</td>
<td></td>
</tr>
<tr>
<td>access data</td>
<td>netCDF</td>
<td>acquisition PC</td>
</tr>
<tr>
<td></td>
<td>ship's web</td>
<td>windows share</td>
</tr>
<tr>
<td></td>
<td>windows share</td>
<td>NFS</td>
</tr>
<tr>
<td>documentation</td>
<td>ship's web</td>
<td>acquisition PC</td>
</tr>
<tr>
<td></td>
<td>www</td>
<td>www</td>
</tr>
<tr>
<td>speedlog out</td>
<td>NB150 only</td>
<td>yes</td>
</tr>
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</table>
ADCP Acquisition systems

- Basic requirements
  - Overview
  - Serial setup
  - Data logging
- Processing
  - Processing components
  - Accessing data products
- Monitoring
## Monitoring

<table>
<thead>
<tr>
<th>monitor</th>
<th>UHDAS</th>
<th>VmDAS</th>
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<tbody>
<tr>
<td>computer</td>
<td>daily report</td>
<td>?</td>
</tr>
<tr>
<td>serial</td>
<td>daily_report</td>
<td>LOG and console</td>
</tr>
<tr>
<td></td>
<td></td>
<td>messages</td>
</tr>
<tr>
<td>ADCP</td>
<td>beam plots</td>
<td>configure plots</td>
</tr>
<tr>
<td>Processing</td>
<td>daily_report</td>
<td>configure plots</td>
</tr>
<tr>
<td></td>
<td>plots</td>
<td></td>
</tr>
<tr>
<td></td>
<td>calibration</td>
<td>no</td>
</tr>
<tr>
<td></td>
<td>ping rate</td>
<td>?</td>
</tr>
<tr>
<td></td>
<td>bottom track</td>
<td>no</td>
</tr>
<tr>
<td>remotely</td>
<td>email to anyone</td>
<td>no</td>
</tr>
</tbody>
</table>

35: Acquisition Systems – Monitoring (2)
Part I: ADCP

- Getting Ocean Velocity
- ADCP Acquisition Systems: UHDAS, VmDAS
- What can go wrong
  - Perspective: systems
  - Perspective: data flow
  - Perspective: symptoms in ocean current
  - Perspective: VmDAS
ADCP: what can go wrong

Viewed from the perspective of:

- ADCP systems (components)
  - Computer
  - ADCP
  - Ancillary: GPS, Heading
- Data flow (where does the problem occur)
- Manifestation in ocean velocities – examples
  - Cross-track error (transducer angle)
  - Along-track error (scale factor)
  - Data loss (4 recent examples)
ADCP: what can go wrong

Viewed from the perspective of:

- ADCP systems (components)
  - Computer
  - ADCP
  - Ancillary: GPS, Heading
- Data flow (where does the problem occur)
- Manifestation in data product – examples
  - Cross-track error (transducer angle)
  - Along-track error (scale factor)
  - Data loss (4 recent examples)
What can go wrong: ADCP System (Computer)

- PC clock is erratic
- PC clock is set to local time
- Poor quality serial feed
  - Too many messages
  - Low baud rate
  - Multiple unbuffered devices

\[\text{Partial loss, Garbled messages}\]
Bad Serial Feeds

VmDAS is vulnerable to bad serial feeds

Demonstration follows...
### VmDAS: Timestamping a serial feed

1. **serial port**

<table>
<thead>
<tr>
<th>Message name</th>
<th>Heading</th>
<th>Pitch</th>
<th>Roll</th>
</tr>
</thead>
<tbody>
<tr>
<td>$PRDID, +000.68, -000.77, 273.37</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2. **VmDAS timestamp**

   $PADCP, 1, 20100620, 223211.66

   - **Message name**
   - **YYYYMMDD**
   - **HHMMSS.SS**
   - **Ensemble number**
## VmDAS serial feed: when it works

<table>
<thead>
<tr>
<th>$PRD ID</th>
<th>Value</th>
<th>Value</th>
<th>Value</th>
<th>Value</th>
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<tbody>
<tr>
<td>+000.16</td>
<td>-000.49</td>
<td>273.48</td>
<td></td>
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<tr>
<td>-000.43</td>
<td>-000.54</td>
<td>273.85</td>
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<td></td>
</tr>
<tr>
<td>1</td>
<td>20100620</td>
<td>223211.66</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-000.45</td>
<td>-000.72</td>
<td>274.12</td>
<td></td>
<td></td>
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<tr>
<td>+000.08</td>
<td>-000.67</td>
<td>274.13</td>
<td></td>
<td></td>
</tr>
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<td>+000.27</td>
<td>-000.45</td>
<td>274.12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-000.26</td>
<td>-000.46</td>
<td>274.35</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-000.68</td>
<td>-000.49</td>
<td>274.65</td>
<td></td>
<td></td>
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<tr>
<td>-000.23</td>
<td>-000.25</td>
<td>274.88</td>
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<tr>
<td>2</td>
<td>20100620</td>
<td>223218.16</td>
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<tr>
<td>+000.56</td>
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<td></td>
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<td>+000.48</td>
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<td>275.15</td>
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<td></td>
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<tr>
<td>-000.01</td>
<td>-002.76</td>
<td>275.33</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-000.02</td>
<td>-001.75</td>
<td>275.43</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>20100620</td>
<td>223223.64</td>
<td></td>
<td></td>
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<tr>
<td>-000.26</td>
<td>+000.05</td>
<td>275.72</td>
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<td>275.74</td>
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</table>
### UHDAS serial timestamping

| UNIXD | 87.6667280, 12.9128355 |
| AGHDT | 092.0, T |
| UNIXD | 87.6667395, 12.9128470 |
| AGHDT | 092.0, T |
| UNIXD | 87.6667511, 12.9128586 |
| AGHDT | 092.4, T |
| UNIXD | 87.6667627, 12.9128701 |
| AGHDT | 092.4, T |
| UNIXD | 87.6667743, 12.9128817 |
| AGHDT | 092.0, T |
| UNIXD | 87.6667858, 12.9128933 |
| AGHDT | 091.7, T |
| UNIXD | 87.6667974, 12.9129049 |
| AGHDT | 091.7, T |
| UNIXD | 87.6668090, 12.9129164 |
| AGHDT | 092.0, T |
| UNIXD | 87.6668206, 12.9129280 |
| AGHDT | 092.2, T |
| UNIXD | 87.6668321, 12.9129396 |
| AGHDT | 092.4, T |
| UNIXD | 87.6668437, 12.9129512 |
VmDAS serial feed: a common problem

$HEROT,010.9,A*23
$HEHDT,157.4,T*28
$HEROT,011.0,A*2B
$HEHDT,1$PADCP,1,20111111,154915.01,0.00
57.7,T*2B
$HEROT,014.2,A*2C
$HEHDT,157.9,T*25
$HEROT,014.0,A*2E
$HEHDT,158.2,T*21
$PADCP,2,20111111,154917.04,0.00
$HEROT,015.6,A*29
$HEHDT,158.4,T*27
$HEROT,016.7,A*2B
$HEHDT,158.7,T*24
$HEROT,015.5,A*2A
$HEHDT,159.0,T*22
$PADCP,3,20111111,154920.06,0.00
$HEROT,015.0,A*2F
<table>
<thead>
<tr>
<th>Command</th>
<th>Value 1</th>
<th>Value 2</th>
<th>Value 3</th>
<th>Value 4</th>
<th>Value 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>$HEROT</td>
<td>010.9, A*23</td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>$HEHDT</td>
<td>157.4, T*28</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$HEROT</td>
<td>011.0, A*2B</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>$HEHDT</td>
<td>1, 20111111, 154915.01, 0.00</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$PADCP</td>
<td>57.7, T*2B</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$HEROT</td>
<td>014.2, A*2C</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$HEHDT</td>
<td>157.9, T*25</td>
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<td></td>
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</tr>
<tr>
<td>$HEROT</td>
<td>014.0, A*2E</td>
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</tr>
<tr>
<td>$HEHDT</td>
<td>158.2, T*21</td>
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<td></td>
</tr>
<tr>
<td>$PADCP</td>
<td>2, 20111111, 154917.04, 0.00</td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>$HEROT</td>
<td>015.6, A*29</td>
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</tr>
<tr>
<td>$HEHDT</td>
<td>158.4, T*27</td>
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</tr>
<tr>
<td>$HEROT</td>
<td>016.7, A*2B</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>$HEHDT</td>
<td>158.7, T*24</td>
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<td></td>
<td></td>
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<tr>
<td>$HEROT</td>
<td>015.5, A*2A</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>$HEHDT</td>
<td>159.0, T*22</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$PADCP</td>
<td>3, 20111111, 154920.06, 0.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$HEROT</td>
<td>015.0, A*2F</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Rudely inserted
Compromised serial data

- multiple feeds
- messages with no checksum
- low baud rate
- coming from a computer (SCS)

$GTG,A,054,35,27209.679,N7.5500,C
8,01HDT,354.5,-2.4,M8685.4,8507.0,03,W*6D
$GPM,0,356,13358,M
$H.4,N,3543,K*
$

$GPG,3505453572727..5,5,N, 6,00.45
$GW,2.,0501.0,272$PADCP,4910,20110507,054659.19,70.00
5,M,94.,4,M,00.0,01,W,65
.01HDT,354.3,-2
$GPM,0,355,13358,M
$H.3,N,3542,K*
$

$GPG,3505453582727..4,1,N, 5,00.45
$GW,2.,0501.0,2726,M,20.,4,M,00.0,01,W,64
.01HDT,354,M,T
$GPVTG,354,T,356,M,09.3,N,17.2,KT

Partial $GPGGA$ position messages
Partial $HEHDT$ heading messages
SUMMARY: For the best VmDAS Serial data....

(1) DO NOT

- push multiple sources into one port
- use long RS232 cables
- send too many messages
- use a high repetition rate (e.g., 10Hz)

(2) DO

- get data directly from the instrument (not a computer)
- choose a higher baud rate

(3) use feeds with a checksum

```
$GPVTG,082,T,084,M,00.1,N,00.1,K*48
```

(checksum: helps Q/C)
What can go wrong – ADCP

• ADCP loss or degradation
  • Loss of range (loud while underway, weak beam)
  • Loss of one beam (not good)
  • Loss of multiple beams (repair/replace)
  • Acoustic interference (another pinger)
  • Ice
  • Bubbles
  • Acoustic noise (results in loss of range)
  • Electrical noise
What can go wrong – ancillary

- Heading
  - Heading device fails
  - Inaccurate heading device (old mechanical gyro)
- Position
  - Position device fails; gappy
- Any: serial feed problems
  - Cable falls out
  - Instrument fails
ADCP: what can go wrong

Viewed from the perspective of:

• ADCP systems (components)
  – Computer
  – ADCP
  – Ancillary: GPS, Heading

• Data flow (where does the problem occur)

• Manifestation in ocean velocities – examples
  – Cross-track error (transducer angle)
  – Along-track error (scale factor)
  – Data loss (4 recent examples)
ADCP: data loss, degradation (1) degraded range and coverage

Bubbles
Electric Noise
Acoustic noise
Lost or weak beam
Thick window
Ringing
Ice

Solution:
Improve the installation

beam velocities
+ transducer orientation + heading + GPS

ocean velocities

51: Things go wrong (system)
ADCP: data loss, degradation (2) remaining data compromised

Solution:
Edit out bad data
Review what remains

Things go wrong (system)
Transducer misalignment
(1) angle off by <10deg

Diagnostic:
Cross-track error

1° error in heading
10 cm/s error in ocean velocity

beam velocities
+ transducer orientation
  + heading
  + GPS
  + ocean velocities

53: Things go wrong (system)
Transducer misalignment
(2) angle off by >90deg (*)

Ocean Surveyor acquires data using **EA** in the calculation of BEAM VELOCITIES. Gross error could irrevocably ruin the data.

Diagnostic:
beam velocities corrupted (wrap)

- beam velocities
- transducer orientation
- heading
- GPS
- ocean velocities

54: Things go wrong (system)

(*) actual value varies with ship
Headings are inaccurate

Diagnostic: Cross-track error

1 deg error in heading
10 cm/s error in ocean velocity

55: Things go wrong (system)
Failure of ancillary (heading, gps)

Solution:
Record multiple sources
Switch to 2\textsuperscript{nd} source
Reprocess with 1\textsuperscript{st}

Instrument failure
Communications failure

beam velocities
+ transducer orientation
+ heading
+ GPS

ocean velocities

56: Things go wrong (system)
Intermittent loss or corruption of ancillary data

Solution:
Record multiple sources
Switch to 2\textsuperscript{nd} source
Reprocess with 1\textsuperscript{st}

57: Things go wrong (system)
ADCP: what can go wrong

Viewed from the perspective of:

- ADCP systems (components)
  - Computer
  - ADCP
  - Ancillary: GPS, Heading
- Data flow (where does the problem occur)
- Manifestation in ocean velocities – examples
  - Cross-track error (transducer angle)
  - Along-track error (scale factor)
  - Data loss (4 recent examples)
What can go wrong: “manifestation in ocean velocities”

(1) Cross-track error:
   - recovery requires accurate heading

(2) Along-track error:
   - may indicate a serious problem
   - recovery may be possible, incomplete, ambiguous

(3) Other:
   - Acoustic interference
   - Underway bias (bad weather)
   - Bad Setup (4 examples)
What can go wrong:
“manifestation in ocean velocities”

(1) Cross-track error:
   - recovery requires accurate heading

(2) Along-track error:
   - may indicate a serious problem
   - recovery may be possible, incomplete, ambiguous

(3) Other:
   - Acoustic interference
   - Underway bias (bad weather)
   - Bad Settings (3 examples)

60: Things go wrong (symptom)
Symptom = Cross-Track Error
Cause = incorrect angle applied

Cross-track bias in ocean velocity from angle error:
(heading + transducer angle)
Symptom = Cross-Track Error
Cause = incorrect angle applied

Angle applied comes from
- Transducer angle (beam “3” clockwise from bow)
- Heading of ship
- If UHDAS,
  - Reliable heading for each ping (eg gyro)
  - Heading correction for each averaging period
  - Calculated relative to devices such as Ashtech, POSMV, Seapath, Mahrs, Phins
Symptom = Cross-Track Error
Cause = incorrect angle applied

Angle applied comes from

- Transducer angle (beam “3” clockwise from bow)

This is a constant value for the whole cruise

Examples of error in transducer angle follow...
Calibration: angle error -3.6 deg

64: Things go wrong (angle, constant error)
Calibration: angle error -1.6

65: Things go wrong (angle, constant error)
Calibration: angle error 0.4

66: Things go wrong  (angle, constant error)
Symptom = Cross-Track Error
Cause = incorrect **angle applied**

**Angle applied** comes from

Heading, which may be in error by

- A constant offset
- A time-dependent offset

Example follows ...
Phins-Gyro difference varies with time

Changes in ship's heading affect heading error

68: Things go wrong (angle, variable)
Effect of Time-Dependent Heading Error on Ocean Velocities

1 degree error in heading means:
- 0.1m/s error in ocean velocity
- in the cross-track direction

Changes in ship's heading affect heading error

69: Things go wrong (angle, variable)
Is this a heading error?

70: Things go wrong (angle, variable, trick question)
Contour plot:

Is this cross-track signal (stripes in N/S ocean velocity) due to a heading error?
Actually, it's really the ocean, but we can't tell without knowing the quality of the accurate heading device.
What can go wrong: “manifestation in ocean velocities”

(1) Cross-track error:
   - recovery requires accurate heading

(2) Along-track error:
   - may indicate a serious problem
   - recovery may be possible, incomplete, ambiguous

(3) Other:
   - Acoustic interference
   - Underway bias (bad weather)
   - Bad Settings (3 examples)
Examples of along-track error

- Acoustic interference
- Underway bias (bad weather)
- Scale factor (NB150 soundspeed correction)
- (things that look like scale factor)
Along-track Error

Bias towards zero in measured velocity
Alongtrack bias in ocean velocity

75: Things go wrong (scale factor, cartoon)
Examples of along-track error

- Acoustic interference
- Underway bias (bad weather)
- Scale factor (NB150 soundspeed correction)
- (things that look like scale factor)
Acoustic Interference: single ping

Signal Strength

Ocean Velocity

Percent Good

os75nb
heading correction: -3.52 deg, 2010/08/11 17:17:51 UTC
Acoustic Inference: averaged
Acoustic interference removed by CODAS processing

VmDAS LTA files:
Unedited prior to averaging

VmDAS ENX files:
Single-ping editing applied
Prior to averaging

- interference from OS75 on OS150
- bias towards zero in measured velocity results in Bias “in the direction of motion” in ocean velocity
- ship was traveling Seattle-Honolulu, i.e. mostly southwest
Examples of along-track error

- Acoustic interference
- Underway bias (bad weather)
- Scale factor (NB150 soundspeed correction)
- (things that look like scale factor)
single-ping editing: underway bias

81: Errors
Averaged (unedited) data: Acoustic interference and underway bias (bubbles)
OS150 underway bias due to poor weather conditions

Biased pings, due to bad weather
- bias towards zero in measured velocities
- bias in direction of motion in ocean velocities
- shorter profiles (degraded quality)

acoustic Interference from OS75 on OS150

Biased pings mostly edited out, but manual post-processing is required
Examples of along-track error

- Acoustic interference
- Underway bias (bad weather)
- Scale factor (NB150 soundspeed correction)
- (things that look like scale factor)
scale factor: alongtrack bias

85: Things go wrong  (scale factor, before)
After scale factor applied

86: Things go wrong (scale factor, after)
Problems that “look like” alongtrack bias

- Time lag between ADCP and heading
- Time lag between ADCP and GPS
- Transducer very different fore/aft from GPS (example)
Transducer not aligned with GPS

...using actual location

...using shifted GPS location

difference

8: alongtrack bias
Things go wrong: VmDAS examples

- Problem Exists
- Solution, for previous data
  - Rely on reprocessing
  - Might require new software
  - Might be able to fix...
  - Might NOT be able to fix
- Solution, for future cruises
  - (fix it)
Things go wrong: VmDAS examples

- (1) Bad Processing settings:
  - Sette: acquiring heading, not using it

- (2) Serial Snafu
  - Gordon Gunter: intermittently awful serial data

- (3) Bad setup
  - (a) Walton Smith: POSMV
    - the ONLY heading source
    - Poor quality
  - (b) MacArthur2: not acquiring heading at all

- (4) Bad luck
  - several: 3 beams
Things go wrong: VmDAS example (1)

- **Problem:** *Bad Processing settings:*
  - Sette: acquiring heading, but not using it
Acquiring headings, but not using...

N2R file

$HEHDT,318.3,T*
$HEHDT,318.5,T*
$HEHDT,318.4,T*
$HEHDT,318.0,T*
$PADCP,6,201107
$HEHDT,317.8,T*
$HEHDT,317.8,T*
$HEHDT,317.9,T*
$PADCP,7,201107
$HEHDT,317.8,T*
$HEHDT,317.7,T*
$HEHDT,317.7,T*
$PADCP,8,201107
$HEHDT,317.6,T*
$HEHDT,317.4,T*
$HEHDT,317.3,T*

Internal sensor only

87.48 ± 1.0 deg

Heading

Pitch

Roll

92: Vmdas examples
Things go wrong: VmDAS example (1)

- **Problem:** Bad Processing Settings:
  - Sette: acquiring heading, but not using it

- **Solution (1):**
  - Reprocess with VmDAS; use heading *(10 hours)*
  - Run through CODAS matlab processing *(2 hours)*

- **Solution (2):**
  - Write additional CODAS software *(many hours)*
  - Stage VmDAS in UHDAS format *(5 min)*
  - Process as UHDAS data; use heading *(15 min)*
Things go wrong: VmDAS example (2)

- Problem: **Serial Snafu**
  - Gordon Gunter: intermittantly awful serial data
Things go wrong: VmDAS example (2)

$GTG,A,054,35,27209.679,N7.5500,C
8,01HDT,354.5,-2.4,M8685.4,8507.0,03,W*6D
$GPM,0,356,13358,M
$H.4,N,3543,K*
$
$GPG,3505453572727..5,5,N,,6,00.45
$GW,2,,0501.0,272$PADCP,4910,20110507,054659.19,70.00
5,M,94.,4,M,00.0,01,W,65
,01HDT,354.3,-2
$GPM,0,355,13358,M
$H.3,N,3542,K*
$
$GPG,3505453582727..4,1,N,,5,00.45
$GW,2,,0501.0,2726,M,20.,4,M,00.0,01,W,64
,01HDT,354,M,T
$GPVTG,354,T,356,M,09.3,N,17.2,KT

Partial $GPGGA$ position messages

Partial $HEHDT$ heading messages

Number of characters per line

bad

good
Things go wrong: VmDAS example (2)

Gordon Gunter: intermittently awful serial data

- Solution for future cruises:
  - Fix it: direct serial feeds from GPS and gyro

- Solution: past cruises
  - Expert: use other data to patch in position, heading
  - MIGHT NOT WORK
  - Resulting Data quality: unknown
    - NOT TESTED; expert level processing; timeconsuming
Things go wrong: VmDAS example (3a)

- Problem: **Bad setup**
  - Walton Smith: POSMV = the ONLY heading source and not rock solid (heading errors)
Things go wrong: VmDAS example (3a)

POSVMV heading accuracy and (good) cutoff

heading: (posmv=red), (gyro =green)
Things go wrong: VmDAS example (3a)

POSMV is unhealthy and is the only heading source

• Solution for future cruises:
  • Log gyro as well

• Solution for past cruises:
  • Expert: use other data to patch in position, heading
  • MIGHT NOT WORK
  • Resulting Data quality: unknown
    - NOT TESTED; expert level processing; timeconsuming
Things go wrong: VmDAS example (3b)

- Problem: **Bad Acquisition Setup**
  - MacArthur2: not acquiring heading at all
Heading is not being logged at all

(1) Only N1R files

(2) No heading field here:

$$\text{GPGGA,230053,3642.4520,N,12214.4982,W,1,8,2.0,19,M,-30,M, ,}$$
$$\text{GPVTG,20.4,T,5.4,M,2.1,N,3.8,K}$$
$$\text{GPZDA,230053,17,07,2010,0,0}$$
$$\text{GPRMC,230053,A,3642.4520,N,12214.4982,W,2.1,20.4,170710,15,E*7F}$$
$$\text{GPGLL,3642.4524,N,12214.4982,W,230054,A}$$
$$\text{GPGGA,230054,3642.4524,N,12214.4982,W,1,8,2.0,19,M,-30,M, ,}$$
$$\text{GPVTG,18.0,T,3.0,M,2.0,N,3.7,K}$$
$$\text{GPZDA,230054,17,07,2010,0,0}$$
$$\text{GPRMC,230054,A,3642.4524,N,12214.4982,W,2.0,18.0,170710,15,E*72}$$
$$\text{GPGLL,3642.4530,N,12214.4981,W,230055,A}$$
$$\text{GPGGA,230055,3642.4530,N,12214.4981,W,1,8,2.0,19,M,-30,M, ,}$$

(3) VmDAS “Transform” Tab – nothing selected!

101: Vmdas examples
<table>
<thead>
<tr>
<th>Leader</th>
<th>NAV</th>
<th>LDR: internal sensor only</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ens Num 1184</td>
<td>Date 13 Jul 2010</td>
<td>Speed Avg Made good Start Time 10:38:05 P.M.</td>
</tr>
<tr>
<td>BIT Err OK</td>
<td>Time 18:38:10.13</td>
<td>Mag Start Lat 37.06 55 N</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Dir Start Lon 124 41 48 W</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Leader</th>
<th>NAV</th>
<th>LDR: internal sensor only</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ens Num 1185</td>
<td>Date 13 Jul 2010</td>
<td>Speed Avg Made good Start Time 10:38:10 P.M.</td>
</tr>
<tr>
<td>BIT Err OK</td>
<td>Time 18:38:15.61</td>
<td>Mag Start Lat 37.06 55 N</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Dir Start Lon 124 41 48 W</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Leader</th>
<th>NAV</th>
<th>LDR: internal sensor only</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ens Num 1186</td>
<td>Date 13 Jul 2010</td>
<td>Speed Avg Made good Start Time 10:38:16 P.M.</td>
</tr>
<tr>
<td>BIT Err OK</td>
<td>Time 18:38:21.10</td>
<td>Mag Start Lat 37.06 55 N</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Dir Start Lon 124 41 48 W</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Leader</th>
<th>NAV</th>
<th>LDR: internal sensor only</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ens Num 1186</td>
<td>Date 13 Jul 2010</td>
<td>Speed Avg Made good Start Time 10:38:20 P.M.</td>
</tr>
<tr>
<td>BIT Err OK</td>
<td>Time 18:38:21.10</td>
<td>Mag Start Lat 37.06 55 N</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Dir Start Lon 124 41 48 W</td>
</tr>
</tbody>
</table>

102: Vmdas examples
Things go wrong: VmDAS example (3b)

MacArthur 2 – not logging heading at all

- Solution for future cruises:
  - Fix it: Acquire Heading

- Solution for past cruises:
  - Expert: use other data to patch in position, heading
  - MIGHT NOT WORK
  - Resulting Data quality: unknown
    - NOT TESTED; expert level processing; timeconsuming
Things go wrong: VmDAS examples

- Problem: Bad luck
  - Various ships: 3 beams (for many months)
- Solution for past cruises:
  - Process data using 3-beam solutions
  - Data quality reduced
- Solution for future cruises:
  - Replace/repair instrument
Part II: UHDAS

- ADCP Processing with CODAS
- UHDAS: What it does
- Monitoring
  - At sea
  - On Land
- What can be changed, tested
NOAA Newport 2012 ADCP

Part II: UHDAS

- ADCP Processing with CODAS
- UHDAS: What it does
- Monitoring
  - At sea
  - On Land
- What can be changed, tested
CODAS Processing Overview

CODAS: Common Ocean Data Access System

- Portable
- Self-descriptive
- aggregated files (vs/ netCDF which is one file)
- designed for ADCP data

“CODAS Processing” → produce ocean velocities

- tools to access and modify CODAS files
CODAS Processing Steps

- read ADCP + ancillary data
- [transform, edit single-pings, average]
- load into CODAS database
- nudge positions to get smooth reference layer
- apply heading corrections (calculated from difference between gyro and accurate heading)
- determine calibration values (angle, scale factor), - apply angle and scale factor
- edit out bad profiles of averaged data
<table>
<thead>
<tr>
<th>Acquisition</th>
<th>Data Stored to Disk</th>
<th>Load the Database</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Program Name</strong></td>
<td><strong>Averaged</strong></td>
<td><strong>Singleping</strong></td>
</tr>
<tr>
<td>DAS2.48</td>
<td>pingdata.*</td>
<td>(no)</td>
</tr>
<tr>
<td>VmDAS</td>
<td>*.STA</td>
<td>load_lta.m</td>
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<tr>
<td></td>
<td>*.LTA</td>
<td></td>
</tr>
<tr>
<td>VmDAS</td>
<td>*.ENR</td>
<td>load_ens.m</td>
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<tr>
<td></td>
<td>*.ENS</td>
<td></td>
</tr>
<tr>
<td></td>
<td>*.ENX</td>
<td></td>
</tr>
<tr>
<td>UHDAS</td>
<td>*.raw</td>
<td>load_uhblk</td>
</tr>
</tbody>
</table>

All subsequent steps use only the data in the CODAS files
These steps use only the CODAS files

```
<table>
<thead>
<tr>
<th>“navigation steps”</th>
<th>do this</th>
<th>data type</th>
<th>how?</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) extract navigation</td>
<td>all (except pingdata)</td>
<td>“Idcodas”</td>
<td></td>
</tr>
<tr>
<td>(2) smooth navigation</td>
<td>all</td>
<td>refsm</td>
<td></td>
</tr>
<tr>
<td>(3) put smoothed nav into CODAS</td>
<td>all</td>
<td>putnav</td>
<td></td>
</tr>
</tbody>
</table>
```

- **test calibration**
  - method
    - watertrack
    - bottom track
    - reciprocal track
  - where?
    - cal/watertrk/adcpcal.out
    - cal/botmtrk/btcaluv.out
    - cal/watertrk/recip.m

- **apply calibrations**
  - “rotate”
    - phase and/or scale factor

- **edit ADCP profiles**
  - run gautoedit, apply editing

repeat as needed

SCIENCE
CODAS Processing Supports...

<table>
<thead>
<tr>
<th>Acquisition program</th>
<th>instrument</th>
<th>ping type</th>
<th>file type (suffix)</th>
<th>Averaged? or raw?</th>
<th>processing in</th>
<th>matlab?</th>
<th>python?</th>
</tr>
</thead>
<tbody>
<tr>
<td>DAS2.48</td>
<td>NB150</td>
<td>nb</td>
<td>pingdata</td>
<td>avg</td>
<td></td>
<td></td>
<td>matlab</td>
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<tr>
<td>VmDAS</td>
<td>Broadband or Workhorse</td>
<td>bb</td>
<td>LTA, STA</td>
<td>avg</td>
<td>matlab</td>
<td></td>
<td>python</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>ENS, ENX</td>
<td>raw</td>
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<tr>
<td></td>
<td>Ocean Surveyor</td>
<td>nb</td>
<td>LTA, STA</td>
<td>avg</td>
<td>matlab</td>
<td></td>
<td>python</td>
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<td>ENS, ENX</td>
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<td>ENR(N1R,N2R)</td>
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<td>python</td>
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<td>nb</td>
<td>ENS, ENX</td>
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<td>matlab</td>
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<td>bb</td>
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<td>ENR(N1R,N2R)</td>
<td>raw</td>
<td>python</td>
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<tr>
<td>UHDAS</td>
<td>NB150,NB300</td>
<td>nb</td>
<td>raw</td>
<td>raw</td>
<td>matlab</td>
<td>python</td>
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<td></td>
<td>Ocean Surveyor</td>
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<td>raw</td>
<td>matlab</td>
<td>python</td>
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<td></td>
<td></td>
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<td>matlab</td>
<td>python</td>
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<tr>
<td></td>
<td>WH300</td>
<td>bb</td>
<td>raw</td>
<td>raw</td>
<td>matlab</td>
<td>python</td>
<td></td>
</tr>
</tbody>
</table>
At Sea

1. UHDAS Data acquisition

At Home

1. Files on the disk

   - `adctree.py`, `quick_adcp.py` (single- ping processing)
   - heading correction (if possible)
   - amplitude and fixed rotation
   - gaucoedit (automated) editing

   UHDAS processing directory,
   UHDAS database

   Post-processing (dataset from the ship)

   - change amplitude correction?
   - change constant rotation?
   - fix heading correction?
   - manual gaucoedit editing

   final processed data

At Sea

1. VmDAS Data acquisition

At Home

1. Files on the disk

   - `adctree.py`, `quick_adcp.py`
   - single- ping (ENX)
   - or
   - averaged (STA, LTZ)

   VmDAS processing directory,
   VmDAS database

   Process data from scratch

   final processed data

112: CODAS
Part II: UHDAS

- ADCP Processing with CODAS
- UHDAS: What it does
- Monitoring
  - At sea
  - On Land
- What can be changed, tested
UHDAS: what it does

- Data acquisition and processing
- Data access (for scientist at sea)
- Monitoring tools
  - at sea
  - from shore
UHDAS: what it does:

Data acquisition ...

- logs and timestamps data
- parses NMEA data (Matlab, Python)

.... and processing

- transforms (ADCP), grids (ancillary), edits (pings)
- averages, loads (into CODAS database)
- all CODAS processing
UHDAS: What it does:

Data Access...

- web site on ship with
  - 5-minute profile (updated 5min)
  - 3-day vector and contour plot (updated 30min)
  - matlab files via web (used in 3-day plots)
- full-resolution processed (5min averages) via
  - samba (windows share), NFS
  - Files in Matlab, NetCDF, or CODAS (+access tools)
UHDAS: What it does

Monitoring...

• **at sea:**
  • processing (web plots)
  • health of accurate heading device (web plots)
  • data acquisition (UHDAS tool)

• **from shore:**
  • sends daily email with attachment
  • diagnostic files
  • data snippet
  • shore-based figures generated from snippet
# UHDAS cruise directory structure

Data for scientists:
There are three categories of data, all located in the logging directory, `/home/data/[CRUISEID]`:

**ADCP logging directories**

<table>
<thead>
<tr>
<th>subdirectory</th>
<th>contents</th>
<th>importance</th>
<th>back up for...</th>
</tr>
</thead>
<tbody>
<tr>
<td>raw</td>
<td>all raw data</td>
<td>critical</td>
<td>archiving</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>scientists who ask for it</td>
</tr>
<tr>
<td>rbin</td>
<td>intermediate files</td>
<td>nice to have</td>
<td>anyone who gets raw</td>
</tr>
<tr>
<td>gbin</td>
<td>intermediate files</td>
<td>nice to have</td>
<td>anyone who gets raw</td>
</tr>
<tr>
<td>proc</td>
<td>final processing</td>
<td>final product</td>
<td>science CDs after cruise</td>
</tr>
<tr>
<td></td>
<td>- codas database</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- underway figure archive</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- matlab files</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Cruise Sequence (for operator)

- Start UHDAS gui
- Start cruise
- Start logging; directory contents of..
  - raw
  - rbin
  - gbin
  - proc
UHDAS gui tool
Part II: UHDAS

- ADCP Processing with CODAS
- UHDAS: What it does
- Monitoring
  - At sea
  - On Land
- What can be changed, tested
Monitoring: At Sea

There are three categories of monitoring:

(1) CODAS Processing
(2) health of components (Ashtech)
(3) data acquisition

Example at-sea web site

122: Monitoring (at sea)
Monitoring: At Sea

There are three categories of monitoring:

(1) CODAS Processing
(2) health of components (Ashtech)
(3) data acquisition
Monitoring At Sea: UHDAS web site

Monitoring: click opens a new figure

Attitude Devices
- ashtech heading correction

Beam Diagnostics (OS only):
- last 30 min
- last 24 files (stats)

Bridge plots:
- surface vector:
  - day
  - night
- kts and direction profile:
  - day
  - night
- kts E/N + scattering profile

Click shows figures on the right:
all thumbnails

124: Monitoring (at sea)
Monitoring the 5-minute timer:
Check: less than 10 minutes old?

**Accurate Heading Device**

Ashtech, POSMV, Seapath
Phins, Mahrs

5-minute profile of each ADCP+Pingtype
UHDAS average (5-minute) profile plot

Acoustic interference (edited out; decreases percent good)

percent good in this 5-minute average, after UHDAS editing

percent good before UHDAS editing

heading correction: 1.11 deg, 2009/02/18 05:11:15 UTC

UTC time of last sample

126: Monitoring (at sea)
Signal strength ("amplitude") in counts. Note the bottom at 350-400m

Percent of pings considered "good" in each bin. Cutoff is 50% or better.

Data are considered "good" if the are
- better than 50PG
- out of range of bottom interference (bottom 15% for an instrument with 30deg beams)

If an accurate heading device exists, and is working, the correction to the gyro is written here for every averaging interval. Values are typically a few degrees or less.

Timestamp should be within 10 minutes of the present

127: Monitoring (at sea)
Monitoring the 30-minute timer: Check: less than 1 hour old?

plot of last 3 days of data generated every 30 minutes one for each ADCP+Pingtype

128: Monitoring (at sea)
Monitoring the accurate heading device: Is it working?

Accurate but possibly intermittent attitude device: figure updates every 5 minutes.

129: Monitoring (at sea)
Monitoring: At Sea

There are three categories of monitoring:

1. CODAS Processing
2. health of components (Ashtech)
3. data acquisition
Attitude Health

- Examples of
  - Ashtech
  - POSMV
  - Phins

- Statistics generated for all 3

- Example of POSMV in trouble
Ashtech

132: Monitoring (at sea)
POSMV

133: Monitoring (at sea)
Phins

134: Monitoring (at sea)
Statistics generated in daily email for three cases

--- ashtech statistics ---
ddrange: 304.7901512 to 305.7901506
all ashtech messages: (89%) were good
(300sec) ensemble heading corrections:
288 out of 288 (100%) were good
statistics of good data:
mean N = 278, stdev N = 27
min = -0.25, max = 0.61
mean = 0.15, stdev = 0.22

--- posmv statistics ---
posmv-gyro statistics (pycurrents)
ddrange: 305.8333642 to 306.8577939
(2010/11/02 20:00:03 to 2010/11/03 20:35:14)
number of good points: 182 out of 294 (62%)
min dh = 0.37, max dh = 1.85
mean dh = 0.89
stdev dh = 0.35
heading correction quality:
mean N in ensemble = 120
stdev N in ensemble = 40
(one ensemble looks like 300 seconds)

--- phins statistics ---
phins-gyro statistics (pycurrents)
ddrange: 305.8333642 to 306.8577936
(2010/11/02 20:00:03 to 2010/11/03 20:35:31)
number of good points: 295 out of 295 (100%)
min dh = -0.12, max dh = 1.97
mean dh = -0.12
stdev dh = 0.38
heading correction quality:
mean N in ensemble = 301
stdev N in ensemble = 0
(one ensemble looks like 300 seconds)
POSMV in trouble

136: Monitoring (at sea)
Monitoring: At Sea

There are three categories of monitoring:

(1) CODAS Processing
(2) health of components (Ashtech)
(3) data acquisition
### Monitoring At Sea: data Acquisition

<table>
<thead>
<tr>
<th>Cruise ID: HLY10TC_14</th>
<th>Control</th>
<th>Terminal</th>
<th>Monitor</th>
<th>G-minPlot</th>
<th>ContourPlot</th>
<th>VectorPlot</th>
<th>BridgePlot</th>
<th>HeadingPlot</th>
<th>Log</th>
<th>Errors</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>os150 tty_dgn0_0</strong></td>
<td></td>
<td></td>
<td>Logging</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Start:</td>
<td>Good: 29</td>
<td>03:27:41</td>
<td></td>
<td>2010/06/08</td>
<td>03/27/41</td>
<td>159 03:27:52</td>
<td>hly2010_159_07200.raw</td>
<td>5105610</td>
<td>2130</td>
<td></td>
</tr>
<tr>
<td>Errors:</td>
<td>0</td>
<td></td>
<td></td>
<td>2010/06/08</td>
<td>03/27/39</td>
<td>159 03:27:55</td>
<td>hly2010_159_07200.raw</td>
<td>5107740</td>
<td>2130</td>
<td></td>
</tr>
<tr>
<td>os75 tty_dgn0_7</td>
<td></td>
<td></td>
<td>Logging</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Start:</td>
<td>Good: 19</td>
<td>03:27:41</td>
<td></td>
<td>2010/06/08</td>
<td>03/27/39</td>
<td>159 03:27:55</td>
<td>hly2010_159_07200.raw</td>
<td>5109870</td>
<td>2130</td>
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<tr>
<td>Errors:</td>
<td>0</td>
<td></td>
<td></td>
<td>2010/06/08</td>
<td>03/27/39</td>
<td>159 03:27:55</td>
<td>hly2010_159_07200.raw</td>
<td>5112000</td>
<td>2130</td>
<td></td>
</tr>
<tr>
<td><strong>GP39 GPS tty_dgn0_2</strong></td>
<td></td>
<td></td>
<td>Logging</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Errors:</td>
<td>0</td>
<td></td>
<td></td>
<td>2010/06/08</td>
<td>03/27/39</td>
<td>159 03:27:55</td>
<td>hly2010_159_07200.raw</td>
<td>2415600</td>
<td>1650</td>
<td></td>
</tr>
<tr>
<td><strong>MK39 gyre tty_dgn0_5</strong></td>
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<td></td>
<td>Logging</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Start:</td>
<td>Good: 1</td>
<td>03:27:41</td>
<td></td>
<td>2010/06/08</td>
<td>03/27/39</td>
<td>159 03:27:55</td>
<td>hly2010_159_07200.raw</td>
<td>2417250</td>
<td>1650</td>
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<tr>
<td>Errors:</td>
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<td></td>
<td></td>
<td>2010/06/08</td>
<td>03/27/39</td>
<td>159 03:27:55</td>
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<td>2418900</td>
<td>1650</td>
<td></td>
</tr>
<tr>
<td><strong>MK27 gyre tty_dgn0_6</strong></td>
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<td>Logging</td>
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</tr>
<tr>
<td>Errors:</td>
<td>0</td>
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<td></td>
<td>2010/06/08</td>
<td>03/27/39</td>
<td>159 03:27:55</td>
<td>hly2010_159_07200.raw</td>
<td>2418900</td>
<td>1650</td>
<td></td>
</tr>
<tr>
<td><strong>Ashtech tty_dgn0_1</strong></td>
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<td>Logging</td>
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</tr>
<tr>
<td>Errors:</td>
<td>0</td>
<td></td>
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<td>2010/06/08</td>
<td>03/27/39</td>
<td>159 03:27:55</td>
<td>hly2010_159_07200.raw</td>
<td>2418900</td>
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<tr>
<td><strong>POSSMV tty_dgn0_3</strong></td>
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<td>Logging</td>
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<td></td>
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<td></td>
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</tr>
<tr>
<td>Errors:</td>
<td>0</td>
<td></td>
<td></td>
<td>2010/06/08</td>
<td>03/27/39</td>
<td>159 03:27:55</td>
<td>hly2010_159_07200.raw</td>
<td>2418900</td>
<td>1650</td>
<td></td>
</tr>
</tbody>
</table>

138: Monitoring (at sea)
UHDAS: Monitoring from shore

Link to on-shore monitoring: UHDAS ships

- text email
- figures
- diagnostic files
# UHDAS:

http://currents.soest.hawaii.edu/uhdas_fromships.html

<table>
<thead>
<tr>
<th>ship</th>
<th>schedules</th>
<th>figure links</th>
<th>daily report</th>
<th>daily email</th>
<th>instruments</th>
</tr>
</thead>
<tbody>
<tr>
<td>N.B.Palmer</td>
<td>schedule</td>
<td>figs</td>
<td>dir</td>
<td>email</td>
<td>NB150, OS38</td>
</tr>
<tr>
<td>L.M.Gould</td>
<td>schedule</td>
<td>figs</td>
<td>dir</td>
<td>email</td>
<td>NB150, OS38</td>
</tr>
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<td>Atl. Explorer</td>
<td>2011, 2012</td>
<td>figs</td>
<td>dir</td>
<td>email</td>
<td>OS75</td>
</tr>
<tr>
<td>Atlantis</td>
<td>2011, 2012</td>
<td>figs</td>
<td>dir</td>
<td>email</td>
<td>OS75</td>
</tr>
<tr>
<td>Endeavor</td>
<td>2011, 2012</td>
<td>figs</td>
<td>dir</td>
<td>email</td>
<td>WH300, OS75</td>
</tr>
<tr>
<td>Kilo Moana</td>
<td>2011, 2012</td>
<td>figs</td>
<td>dir</td>
<td>email</td>
<td>WH300, OS38</td>
</tr>
<tr>
<td>Knorr</td>
<td>2011, 2012</td>
<td>figs</td>
<td>dir</td>
<td>email</td>
<td>WH300, OS75</td>
</tr>
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<td>Langseth</td>
<td>2011, 2012</td>
<td>figs</td>
<td>dir</td>
<td>email</td>
<td>OS75</td>
</tr>
<tr>
<td>Melville</td>
<td>2011, 2012</td>
<td>figs</td>
<td>dir</td>
<td>email</td>
<td>OS150, OS75</td>
</tr>
<tr>
<td>New Horizon</td>
<td>2011, 2012</td>
<td>figs</td>
<td>dir</td>
<td>email</td>
<td>OS75</td>
</tr>
<tr>
<td>Oceanus</td>
<td>2011, 2012</td>
<td>figs</td>
<td>dir</td>
<td>email</td>
<td>NB150, OS75</td>
</tr>
<tr>
<td>Revelle</td>
<td>2011, 2012</td>
<td>figs</td>
<td>dir</td>
<td>email</td>
<td>NB150, OS75</td>
</tr>
<tr>
<td>Sproul</td>
<td>2011, 2012</td>
<td>figs</td>
<td>dir</td>
<td>email</td>
<td>NB300</td>
</tr>
<tr>
<td>Thompson</td>
<td>2011, 2012</td>
<td>figs</td>
<td>dir</td>
<td>email</td>
<td>OS75</td>
</tr>
<tr>
<td>Wecoma</td>
<td>2011, 2012</td>
<td>figs</td>
<td>dir</td>
<td>email</td>
<td>WH300, OS75</td>
</tr>
<tr>
<td>Hi`ialakai</td>
<td>figs</td>
<td>dir</td>
<td>email</td>
<td></td>
<td>OS75</td>
</tr>
<tr>
<td>Ka`imimoana</td>
<td>figs</td>
<td>dir</td>
<td>email</td>
<td></td>
<td>OS75</td>
</tr>
<tr>
<td>Ron Brown</td>
<td>figs</td>
<td>dir</td>
<td>email</td>
<td></td>
<td>OS75</td>
</tr>
<tr>
<td>Healy</td>
<td>figs</td>
<td>dir</td>
<td>email</td>
<td></td>
<td>OS150, OS75</td>
</tr>
<tr>
<td>Ka`imikai O Kanaloa</td>
<td>figs</td>
<td>dir</td>
<td>email</td>
<td></td>
<td>NB150</td>
</tr>
</tbody>
</table>

140: Monitoring (from shore)
Monitoring: From Shore

• from the text email:
  • CODAS Processing
  • health of heading device (eg. Ashtech)
  • PC clock
  • Bottom track (on/off), ping rate (triggered)

• from the diagnostic files:
  • data acquisition
  • processing
  • troubleshooting

141: Monitoring (from shore)
Monitoring: From Shore

- **from the text email:**
  - CODAS Processing
  - health of heading device (eg. Ashtech)
  - PC clock
  - Bottom track (on/off), ping rate (triggered)

Description follows...
2010/11/03 20:40:01
currents 2.6.24-25-generic

Current cruise: TN256  ** is logging **
Database time ranges:
    os75bb 2010/10/23 18:14:25 to 2010/11/03 20:17:14 (22 min. ago)

---- heading correction ----
(heading correction from "posmv")
------ posmv ------
posmv_gyrodh.asc

ddrange: 305.8656494 to 306.8552328

number of good points: 286 out of 286 (100%)  
heading correction statistics:
   min dh = -2.17,  max dh = -0.41
   mean dh = -1.14
   stddev dh = 0.08

--------- uptime ---------
  20:40:02 up 184 days, 22:13,  3 users,  load average: 0.03, 0.22, 0.24
--------- ntpq -p ---------

remote  refid  st  t when poll reach  delay  offset  jitter
--------- --------- --------- ------------- --------- --------- ---------
*ntpserver.thomp .GPS.  1 u  862 1024 377  0.427  -2.542  2.255

figures are at http://currents.soest.hawaii.edu/uhdas_fromships/thompson/figs/
(1) Check the time of the email (this is UTC time)

This email was generated on the ship at 20:40 and mailed out shortly after that.

Expect: email is generated daily, sent shortly after creation

<table>
<thead>
<tr>
<th>Indicator of a problem</th>
<th>How to proceed</th>
</tr>
</thead>
<tbody>
<tr>
<td>email is over 24hrs old</td>
<td>check ship schedule:</td>
</tr>
<tr>
<td></td>
<td>- are they in port for a long time? (computer may be off)</td>
</tr>
<tr>
<td></td>
<td>- are they at sea?</td>
</tr>
<tr>
<td></td>
<td>check with techs: is email and networking up?</td>
</tr>
</tbody>
</table>
Current cruise: TN256  ** is logging **

Expect one of these
(1) ** is logging ** serial acquisition is active
(2) ** not logging ** cruise started but not logging
(3) no cruise set no cruise set

Indicator of a problem

Current cruise: LMG1007  ** is logging **
DAS_while_logging.py is *not* running.

How to proceed
Tech at sea should:
- stop logging
- start logging
- make sure figures
- start updating

145: Monitoring (from shore)
<table>
<thead>
<tr>
<th>Indicator of a problem</th>
<th>How to proceed</th>
</tr>
</thead>
<tbody>
<tr>
<td>data are much older than 30min and DAS_while_logging.log is <strong>not</strong> running</td>
<td>Tech at sea should restart logging</td>
</tr>
<tr>
<td>data are much older than 30 min and no other clue is given</td>
<td>look in daily_report directory for clues;</td>
</tr>
</tbody>
</table>
Check the percentage of good points. If less than 80, tech at sea should check the device.
2010/11/03 20:40:01
currents 2.6.24-25-generic

Current cruise: TN256 ** is logging **
Database time ranges:
    os75bb 2010/10/23 18:14:25 to 2010/11/03 20:17:14 (22 min. ago)

---- heading correction ----
(heading correction from "posmv")
---- posmv -----
posmv_gyrodh.asc
ddrange: 305.8656494 to 306.8552328

number of good points: 286 out of 286 (100%)
heading correction statistics:
    min dh = -2.17, max dh = -0.41
    mean dh = -1.14
    stddev dh = 0.08

---------- uptime ----------
20:46:02 up 184 days, 22:13, 3 users, load average: 0.03, 0.22, 0.24

---------- ntpq -p ----------
remote refid st t when poll reach delay offset jitter
ntpserver.thomp .GPS. 1 u 862 1024 377 0.427 -2.542 2.255

Expect
(1) floating point numbers
(2) ntp not active

Problem: if numbers are all 0.000
2010/11/03 20:40:01
currents 2.6.24-25-generic

Current cruise: TN256  ** is logging **
Database time ranges:
   os75bb 2010/10/23  18:14:25 to 2010/11/03  20:17:14  (22 min. ago)

---- heading correction ----
(heading correction from "posmv")
------- posmv -------
posmv_gyrodh.asc

ddrange: 305.8656494 to 306.8552328

number of good points: 286 out of 286 (100%)
heading correction statistics:
   min dh = -2.17, max dh = -0.41
   mean dh = -1.14
   stddev dh = 0.08

----------- uptime -----------
20:40:02 up 184 days, 22:13, 3 users, load average: 0.03, 0.22, 0.24
----------- ntpq -p -----------
remote       refid   st  t  when poll  reach  delay  offset  jitter
*ntpserver.thomp .GPS.   1 u  862 1024 377  0.427 -2.542  2.255

--- figures ---
figures are at http://currents.soest.hawaii.edu/uhdas_fromships/thompson/figs/

check the figures in the link

149: Monitoring (from shore)
Steps to check daily email:

Observations:
(1) two ping types (OS75 interleaved mode)
(2) data from different types are consistent
(3) data are physically reasonable
   - no big gaps
   - no big outliers
   - no deep strong currents
   - depth ranges are reasonable
Check: (text email)
   BOTTOM TRACK should be OFF
Monitoring: From Shore

- from the diagnostic files:
  - “tails.txt”
    - data acquisition
    - processing
    - troubleshooting
  - “cals.txt”
    - calibration
Diagnostics reminder:  
UHDAS cruise directory structure

Data for scientists:  
There are three categories of data, all located in the logging directory, /home/data/[CRUISEID]:  
ADCP logging directories

<table>
<thead>
<tr>
<th>subdirectory</th>
<th>contents</th>
<th>importance</th>
<th>back up for...</th>
</tr>
</thead>
<tbody>
<tr>
<td>raw</td>
<td>all raw data</td>
<td>critical</td>
<td>- archiving</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- scientists who ask for it</td>
</tr>
<tr>
<td>rbin</td>
<td>intermediate files</td>
<td>nice to have</td>
<td>anyone who gets raw</td>
</tr>
<tr>
<td>gbin</td>
<td>intermediate files</td>
<td>nice to have</td>
<td>anyone who gets raw</td>
</tr>
<tr>
<td>proc</td>
<td>- final processing</td>
<td>final product</td>
<td>science CDs after cruise</td>
</tr>
<tr>
<td></td>
<td>- codas database</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- underway figure archive</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- matlab files</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

File tails.txt shows recent contents of raw, rbin, gbin
UHDAS diagnostic file: tails.txt

- last 12 lines of each NMEA (or log) file
- last 12 raw files (each kind)
- last 12 rbin files (each kind)
- last 12 gbin files (each kind)
UHDAS diagnostic file: cals.txt

keep an eye on calibration

---

**Good ADCP Calibration numbers**

2010/11/05 20:40:02

---

**BOTTOM TRACK**

- unedited: 310 points
- edited: 214 points, 2.0 min speed, 2.5 max dev

<table>
<thead>
<tr>
<th>median</th>
<th>mean</th>
<th>std</th>
</tr>
</thead>
<tbody>
<tr>
<td>amplitude</td>
<td>1.0020</td>
<td>1.0033</td>
</tr>
<tr>
<td>phase</td>
<td>0.0358</td>
<td>0.0679</td>
</tr>
</tbody>
</table>

---

**WATER TRACK**

- Number of edited points: 85 out of 90

<table>
<thead>
<tr>
<th>median</th>
<th>mean</th>
<th>std</th>
</tr>
</thead>
<tbody>
<tr>
<td>amplitude</td>
<td>0.9990</td>
<td>1.0004</td>
</tr>
<tr>
<td>phase</td>
<td>-0.0200</td>
<td>-0.0989</td>
</tr>
</tbody>
</table>

Phase (angle misalignment) should be between -0.5 and +0.5 degrees
NOAA Newport 2012 ADCP

Part II: UHDAS

• ADCP Processing with CODAS
• UHDAS: What it does
• Monitoring
  • At sea
  • On Land
• What can be changed, tested
UHDAS: what can be changed (not much)

with the UHDAS tool:

- bb, nb mode (OS75, OS150)
- bottom tracking on/off
- bin size (and blank)

if required (carefully edit sensor_cfg.py)
- serial port, baud rate
UHDAS: what they'll ask for

“It's up to you but I don't recommend it”

• smaller bins than the default
• bottom tracking on
  • Does not solve anything
  • Most useful for troubleshooting
UHDAS: what they'll ask for

“I think the answer is 'no' but ask Jules”

- more rapid updating of the database
- finer grain than 5min averages

The answer is 'no', in order to preserve the reliability of the UHDAS installation
Configuration Files (expert)

- **proc_cfg.py**
  - transducer angle
  - serial inputs used for transformations
- **uhdas_cfg.py**
  - averaging interval
  - timers (5min, 30min)
  - bin range for bridge plots and vector plot
  - email
- **sensor_cfg.py**
  - ports
  - baud rates
  - messages
Block diagram of sensor_cfg.py

This is a python program. Python is sensitive to Case Indentation Punctuation
sensor_cfg.py : ADCP setup

ADCPs = [
    adcp1_setupdict,
    adcp2_setupdict
]

adcp1_setupdict = {
    'instrument' : 'wh300',
    'setup' : 'rdi_setup',
    'terminal' : 'oswh_term',
    'defaultcmd' : 'wh300 default_cmd',
    'commands' : ('EA04500',),
    'datatypes' : ('wh300',),
    'wakeup_baud' : 9600
}

Only one editable field in this block: This “EA” command must be similar to (within 5-10deg) of the transducer angle, i.e. the angle beam 3 makes from the bow (viewed clockwise from above).

It is CRITICAL to get the EA command in the right ballpark. A bad specification can irrevocably damage the data.
sensor_cfg.py: serial logging setup

sensors = [
    adcp1_logdict,
    adcp2_logdict,
    serial1_logdict,
    serial2_logdict,
    serial3_logdict,
    serial4_logdict,
    serial5_logdict,
    serial6_logdict,
]

Two editable fields:
serial port  baud rate

adcp1_logdict = {
    'instrument' : 'os38',
    'device'     : 'ttyR3',
    'baud'       : 38400,
    'format'     : 'binary',
    'subdir'     : 'os38',
    'ext'        : 'raw',
    'opt'        : oswh_opts
}

Two editable fields:
serial port  baud rate

serial3_logdict = {
    'instrument' : 'ADU5',
    'device'     : 'ttyR6',
    'baud'       : 9600,
    'format'     : 'ascii',
    'subdir'     : 'ashtech',
    'ext'        : 'adu',
    'strings'    : ('$PASHR,ATT', '$GPGGA'),
    'messages'   : ('gps', 'adu'),
    'opt'        : '-tc'
}

These are related to processing... 
TAKE CARE
UHDAS/CODAS NOAA Presentation: Links to the documentation

Part I: ADCP

- Getting Ocean Velocity
- ADCP Acquisition Systems:
  - VmDAS (TRDI), UHDAS
- What can go wrong

Part II: UHDAS

- ADCP Processing with CODAS
- What it does
- Monitoring (at sea, from shore)
- What can be changed, tested