

RV Investigator

ADCP Processing Report

Voyage:	IN2022_V08
Voyage title:	Biodiversity Assessment of Australia's Indian Ocean Territories
Depart:	Darwin, NT, 0900 Friday 30 th September 2022
Return:	Henderson WA, 0800 Thursday 3 rd November 2022
Chief Scientist:	Tim O'Hara (Museum Victoria)
Data Processor	Vito Dirita (CSIRO – E&T Data Acquisition and Processing)

Document History

Date	Version	Author	Comments
02 Aug 2022	1.0	Stephanie Petillo	ADCP Report Template
13 Dec 2022	1.1	Vito Dirita	Draft Version (to be reviewed)
06 Mar 2023	1.2	Vito Dirita, Stephanie Petillo	Final Release version



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1 Summary

As required, one or both ADCPs were turned off in less than 500 m depths to avoid the significant acoustic interference these systems generate, particularly between the OS75 and EM710. Changes to the ADCPs were logged and DAP were informed when multibeam bathymetry was considered a scientific priority. The OS75 was switched off for significant parts of the voyage, especially around Christmas and Cocos (Keeling) Islands while shallow water mapping was being undertaken.

Throughout the voyage there were high counts of low-quality position data from Seapath. In collaboration with UHDAS Support, on the 2022-10-10 the ADCP was configured to use POSMV rather than Seapath for position and heading data, consequently the data has been split into two parts.

ADCP data were collected using the University of Hawaii Data Acquisition System (UHDAS) and post-processed using the Common Ocean Data Access System (CODAS). Documentation for these systems can be found here: https://currents.soest.hawaii.edu/docs/adcp_doc.

Both the RDI Ocean Surveyor 150kHz ADCP and the RDI Ocean Surveyor 75kHz ADCP were run in narrowband mode. The OS150 ADCP was used throughout the voyage. The OS75 was used in deep waters and turned off in shallower waters so as not to interfere with the EM710

Internal triggering was used. The drop keel was at 8 m below the waterline for the duration of the voyage. See the voyage computing and electronics report for more details regarding data acquisition.

2 Voyage Details

2.1 Voyage Objectives

The primary objectives of the voyage were characterisation, sampling, deep-towed video and multibeam mapping of seamounts in Australia's Indian Ocean Territories.

Biological samples were successfully collected and catalogued with the Deployment Recording System (DRS). CTDs were conducted to characterise the water at the sampling sites and were recorded with the CSIRO EVERLog event recording software.

Deep towed video transects were conducted successfully with live stream to shore and shipwide via the intranet web site. Multibeam activities required turning off the OS75 ADCP for short periods of time in shallow water.

DATA DATES:

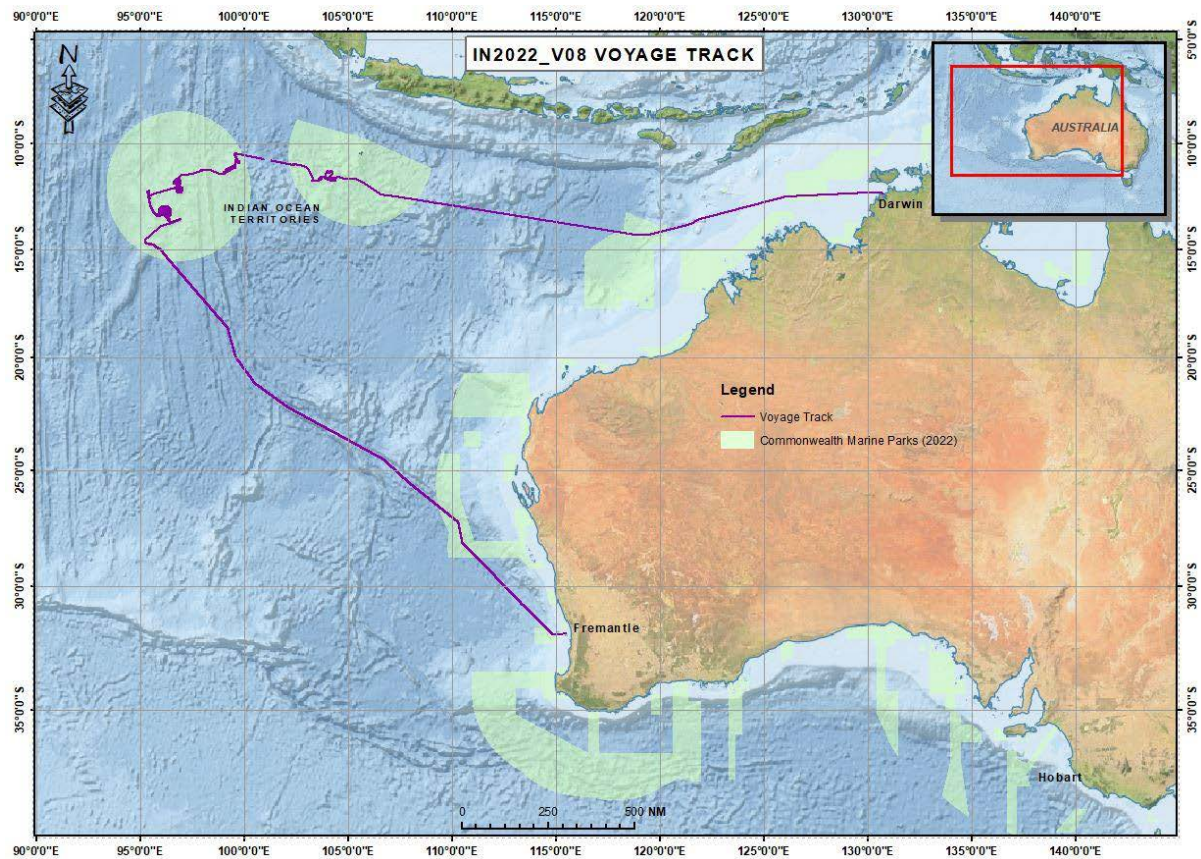
Part-1:

OS75nb:	02 Oct.2022 05:32	-	10 Oct.2022 00:17	(274.23 - 282.01 UTC)
OS150nb:	30 Sep.2022 01:32	-	10 Oct.2022 00:17	(272.06 - 282.01 UTC)

Part-2:

OS75nb:	10 Oct.2022 00:26	-	02 Nov.2022 19:19	(282.02 - 305.81 UTC)
OS150nb:	10 Oct.2022 00:26	-	03 Nov.2022 01:22	(282.02 - 306.06 UTC)

2.2 Area of Operation



Please see the webpy folders for plots of collected data.

3 Data Processing

3.1 Background Information

The University of Hawaii's CODAS software contained in their "focal_20.04" Virtual Machine image was used for data post-processing.

3.2 Processing Notes

Only minor editing was required, data was masked where instrument anomalies were suspected and where the os75 and os150 data differed significantly. No heading correction were applied as all data were within acceptable limits. No additional amplitude or phase adjustments were applied to the transducer angles of any of the data as they were all within acceptable limits.

Instrument Serial Numbers:

Manufacturer	Instrument	Serial Number
TRDI	ADCP 75 KHz	65008
TRDI	ADCP 150 KHz	61315

4 netCDF Data Headers

4.1 OS75nb Part-1:

```
codaspy:(os75nb)$ ncdump -h in2022_v08_os75nb_pt1.nc
netcdf in2022_v08_os75nb_pt1 {
dimensions:
    time = 2242 ;
    depth_cell = 60 ;
variables:
    int trajectory ;
        trajectory:standard_name = "trajectory_id" ;
    double time(time) ;
        time:long_name = "Decimal day" ;
        time:units = "days since 2022-01-01 00:00:00" ;
        time:C_format = "%12.5f" ;
        time:standard_name = "time" ;
        time:data_min = 274.230671296296 ;
        time:data_max = 282.011909722222 ;
    double lon(time) ;
        lon:missing_value = 1.e+38 ;
        lon:long_name = "Longitude" ;
        lon:units = "degrees_east" ;
        lon:C_format = "%9.4f" ;
        lon:standard_name = "longitude" ;
        lon:data_min = 100.088222222222 ;
        lon:data_max = 121.461594444444 ;
    double lat(time) ;
        lat:missing_value = 1.e+38 ;
        lat:long_name = "Latitude" ;
        lat:units = "degrees_north" ;
        lat:C_format = "%9.4f" ;
        lat:standard_name = "latitude" ;
        lat:data_min = -14.3360333333333 ;
        lat:data_max = -10.5764472222222 ;
    float depth(time, depth_cell) ;
        depth:missing_value = 1.e+38f ;
        depth:long_name = "Depth" ;
        depth:units = "meter" ;
        depth:C_format = "%8.2f" ;
        depth:positive = "down" ;
        depth:data_min = 29.99f ;
        depth:data_max = 973.99f ;
    float u(time, depth_cell) ;
        u:missing_value = 1.e+38f ;
        u:long_name = "Zonal velocity component" ;
        u:units = "meter second-1" ;
        u:C_format = "%7.2f" ;
        u:data_min = -0.8696673f ;
        u:data_max = 0.5282269f ;
    float v(time, depth_cell) ;
        v:missing_value = 1.e+38f ;
        v:long_name = "Meridional velocity component" ;
        v:units = "meter second-1" ;
        v:C_format = "%7.2f" ;
        v:data_min = -0.6972071f ;
        v:data_max = 0.5793976f ;
    short amp(time, depth_cell) ;
        amp:missing_value = 32767s ;
        amp:long_name = "Received signal strength" ;
        amp:C_format = "%d" ;
        amp:data_min = 22s ;
        amp:data_max = 180s ;
    byte pg(time, depth_cell) ;
        pg:missing_value = -1b ;
        pg:long_name = "Percent good pings" ;
        pg:C_format = "%d" ;
        pg:data_min = 0b ;
        pg:data_max = 100b ;
    byte pflag(time, depth_cell) ;
```

```

        pflag:long_name = "Editing flags" ;
        pflag:C_format = "%d" ;
        pflag:data_min = 0b ;
        pflag:data_max = 2b ;
float heading(time) ;
    heading:missing_value = 1.e+38f ;
    heading:long_name = "Ship heading" ;
    heading:units = "degrees" ;
    heading:C_format = "%6.1f" ;
    heading:data_min = -178.3517f ;
    heading:data_max = 176.9926f ;
float tr_temp(time) ;
    tr_temp:missing_value = 1.e+38f ;
    tr_temp:long_name = "ADCP transducer temperature" ;
    tr_temp:units = "Celsius" ;
    tr_temp:C_format = "%4.1f" ;
    tr_temp:data_min = 26.7553f ;
    tr_temp:data_max = 28.98076f ;
short num_pings(time) ;
    num_pings:long_name = "Number of pings averaged per ensemble" ;
    num_pings:units = "None" ;
    num_pings:C_format = "%d" ;
    num_pings:data_min = 132s ;
    num_pings:data_max = 133s ;
float uship(time) ;
    uship:missing_value = 1.e+38f ;
    uship:long_name = "Ship zonal velocity component" ;
    uship:units = "meter second-1" ;
    uship:C_format = "%9.4f" ;
    uship:data_min = -6.338005f ;
    uship:data_max = 4.380484f ;
float vship(time) ;
    vship:missing_value = 1.e+38f ;
    vship:long_name = "Ship meridional velocity component" ;
    vship:units = "meter second-1" ;
    vship:C_format = "%9.4f" ;
    vship:data_min = -4.666216f ;
    vship:data_max = 5.279011f ;

// global attributes:
:featureType = "trajectoryProfile" ;
:history = "Created: 2022-12-13 02:39:15 UTC" ;
:Conventions = "COARDS" ;
:software = "pycurrents" ;
:hg_changeset = "3211:63370479787a" ;
:title = "Shipboard ADCP velocity profiles" ;
:description = "Shipboard ADCP velocity profiles from in2022_v08_pt1 using instrument os75nb -
Short Version." ;
:cruise_id = "in2022_v08_pt1" ;
:sonar = "os75nb" ;
:yearbase = 2022 ;
:ship_name = "RV_Investigator" ;
:CODAS_variables = "\n",
    "Variables in this CODAS short-form Netcdf file are intended for most end-user\n",
    "scientific analysis and display purposes. For additional information see\n",
    "the CODAS_processing_note global attribute and the attributes of each\n",
    "of the variables.\n",
    "\n",
    "\n",
    "=====\n",
    "time      Time at the end of the ensemble, days from start of year.\n",
    "lon, lat  Longitude, Latitude from GPS at the end of the ensemble.\n",
    "u,v       Ocean zonal and meridional velocity component profiles.\n",
    "uship, vship  Zonal and meridional velocity components of the ship.\n",
    "heading   Mean ship heading during the ensemble.\n",
    "depth     Bin centers in nominal meters (no sound speed profile correction).\n",
    "tr_temp   ADCP transducer temperature.\n",
    "pg        Percent Good pings for u, v averaging after editing.\n",
    "pflag     Profile Flags based on editing, used to mask u, v.\n",
    "amp       Received signal strength in ADCP-specific units; no correction\n",
    "          for spreading or attenuation.\n",
    "=====\n",
    "\n",
    "" ;

```

```
:CODAS_processing_note = "\n",
"CODAS processing note:\n",
"=====\n",
"\n",
"Overview\n",
"-----\n",
"The CODAS database is a specialized storage format designed for\n",
"shipboard ADCP data. \"CODAS processing\" uses this format to hold\n",
"averaged shipboard ADCP velocities and other variables, during the\n",
"stages of data processing. The CODAS database stores velocity\n",
"profiles relative to the ship as east and north components along with\n",
"position, ship speed, heading, and other variables. The netCDF *short*\n",
"form contains ocean velocities relative to earth, time, position,\n",
"transducer temperature, and ship heading; these are designed to be\n",
"\"ready for immediate use\". The netCDF *long* form is just a dump of\n",
"the entire CODAS database. Some variables are no longer used, and all\n",
"have names derived from their original CODAS names, dating back to the\n",
"late 1980's.\n",
"\n",
"Post-processing\n",
"-----\n",
"CODAS post-processing, i.e. that which occurs after the single-ping\n",
"profiles have been vector-averaged and loaded into the CODAS database,\n",
"includes editing (using automated algorithms and manual tools),\n",
"rotation and scaling of the measured velocities, and application of a\n",
"time-varying heading correction. Additional algorithms developed more\n",
"recently include translation of the GPS positions to the transducer\n",
"location, and averaging of ship's speed over the times of valid pings\n",
"when Percent Good is reduced. Such post-processing is needed prior to\n",
"submission of \"processed ADCP data\" to JASADCP or other archives.\n",
"\n",
"Full CODAS processing\n",
"-----\n",
"Whenever single-ping data have been recorded, full CODAS processing\n",
"provides the best end product.\n",
"\n",
"Full CODAS processing starts with the single-ping velocities in beam\n",
"coordinates. Based on the transducer orientation relative to the\n",
"hull, the beam velocities are transformed to horizontal, vertical, and\n",
"\"error velocity\" components. Using a reliable heading (typically from\n",
"the ship's gyro compass), the velocities in ship coordinates are\n",
"rotated into earth coordinates.\n",
"\n",
"Pings are grouped into an \"ensemble\" (usually 2-5 minutes duration)\n",
"and undergo a suite of automated editing algorithms (removal of\n",
"acoustic interference; identification of the bottom; editing based on\n",
"thresholds; and specialized editing that targets CTD wire interference\n",
"and \"weak, biased profiles\". The ensemble of single-ping velocities\n",
"is then averaged using an iterative reference layer averaging scheme.\n",
"Each ensemble is approximated as a single function of depth, with a\n",
"zero-average over a reference layer plus a reference layer velocity\n",
"for each ping. Adding the average of the single-ping reference layer\n",
"velocities to the function of depth yields the ensemble-average\n",
"velocity profile. These averaged profiles, along with ancillary\n",
"measurements, are written to disk, and subsequently loaded into the\n",
"CODAS database. Everything after this stage is \"post-processing\".\n",
"\n",
"note (time):\n",
"-----\n",
"Time is stored in the database using UTC Year, Month, Day, Hour,\n",
"Minute, Seconds. Floating point time \"Decimal Day\" is the floating\n",
"point interval in days since the start of the year, usually the year\n",
"of the first day of the cruise.\n",
"\n",
"note (heading):\n",
"-----\n",
"CODAS processing uses heading from a reliable device, and (if\n",
"available) uses a time-dependent correction by an accurate heading\n",
"device. The reliable heading device is typically a gyro compass (for\n",
"example, the Bridge gyro). Accurate heading devices can be POSMV,\n",
"Seapath, Phins, Hydrins, MAHRS, or various Ashtech devices; this\n",
"varies with the technology of the time. It is always confusing to\n",
"keep track of the sign of the heading correction. Headings are written
```



```

"degrees, positive clockwise. setting up some variables:\n",
"\n",
"X = transducer angle (CONFIG1_heading_bias)\n",
"  positive clockwise (beam 3 angle relative to ship)\n",
"G = Reliable heading (gyrocompass)\n",
"A = Accurate heading\n",
"dh = G - A = time-dependent heading correction (ANCIL2_watrkh_hd_misalign)\n",
"\n",
"Rotation of the measured velocities into the correct coordinate system\n",
"amounts to (u+i*v)*(exp(i*theta)) where theta is the sum of the\n",
"corrected heading and the transducer angle.\n",
"\n",
"theta = X + (G - dh) = X + G - dh\n",
"\n",
"\n",
"Watertrack and Bottomtrack calibrations give an indication of the\n",
"residual angle offset to apply, for example if mean and median of the\n",
"phase are all 0.5 (then R=0.5). Using the \"rotate\" command,\n",
"the value of R is added to \"ANCIL2_watrkh_hd_misalign\".\n",
"\n",
"new_dh = dh + R\n",
"\n",
"Therefore the total angle used in rotation is\n",
"\n",
"new_theta = X + G - dh_new\n",
"           = X + G - (dh + R)\n",
"           = (X - R) + (G - dh)\n",
"\n",
"The new estimate of the transducer angle is: X - R\n",
"ANCIL2_watrkh_hd_misalign contains: dh + R\n",
"\n",
"=====\n",
"\n",
"Profile flags\n",
"-----\n",
"Profile editing flags are provided for each depth cell:\n",
"\n",


| binary | decimal | below  | Percent |     |
|--------|---------|--------|---------|-----|
| value  | value   | bottom | Good    | bin |
| 000    | 0       |        |         |     |
| 001    | 1       |        |         | bad |
| 010    | 2       |        | bad     |     |
| 011    | 3       |        | bad     | bad |
| 100    | 4       | bad    |         |     |
| 101    | 5       | bad    |         | bad |
| 110    | 6       | bad    | bad     |     |
| 111    | 7       | bad    | bad     | bad |


"\n",
"" ;
}

```

4.2 OS150nb (Part-1)

```

codaspy:(os150nb)$ ncdump -h in2022_v08_os150nb_pt1.nc
netcdf in2022_v08_os150nb_pt1 {
dimensions:
    time = 2863 ;
    depth_cell = 60 ;
variables:
    int trajectory ;
        trajectory:standard_name = "trajectory_id" ;
    double time(time) ;
        time:long_name = "Decimal day" ;
        time:units = "days since 2022-01-01 00:00:00" ;
        time:C_format = "%12.5f" ;
        time:standard_name = "time" ;
        time:data_min = 272.063958333333 ;
        time:data_max = 282.011898148148 ;
    double lon(time) ;

```



```
lon:missing_value = 1.e+38 ;
lon:long_name = "Longitude" ;
lon:units = "degrees_east" ;
lon:C_format = "%9.4f" ;
lon:standard_name = "longitude" ;
lon:data_min = 100.088319444444 ;
lon:data_max = 130.881844444444 ;
double lat(time) ;
lat:missing_value = 1.e+38 ;
lat:long_name = "Latitude" ;
lat:units = "degrees_north" ;
lat:C_format = "%9.4f" ;
lat:standard_name = "latitude" ;
lat:data_min = -14.3360305555556 ;
lat:data_max = -10.5764666666667 ;
float depth(time, depth_cell) ;
depth:missing_value = 1.e+38f ;
depth:long_name = "Depth" ;
depth:units = "meter" ;
depth:C_format = "%8.2f" ;
depth:positive = "down" ;
depth:data_min = 17.93f ;
depth:data_max = 489.96f ;
float u(time, depth_cell) ;
u:missing_value = 1.e+38f ;
u:long_name = "Zonal velocity component" ;
u:units = "meter second-1" ;
u:C_format = "%7.2f" ;
u:data_min = -1.013837f ;
u:data_max = 0.5678678f ;
float v(time, depth_cell) ;
v:missing_value = 1.e+38f ;
v:long_name = "Meridional velocity component" ;
v:units = "meter second-1" ;
v:C_format = "%7.2f" ;
v:data_min = -0.700001f ;
v:data_max = 0.7456438f ;
short amp(time, depth_cell) ;
amp:missing_value = 32767s ;
amp:long_name = "Received signal strength" ;
amp:C_format = "%d" ;
amp:data_min = 21s ;
amp:data_max = 228s ;
byte pg(time, depth_cell) ;
pg:missing_value = -1b ;
pg:long_name = "Percent good pings" ;
pg:C_format = "%d" ;
pg:data_min = 0b ;
pg:data_max = 100b ;
byte pflag(time, depth_cell) ;
pflag:long_name = "Editing flags" ;
pflag:C_format = "%d" ;
pflag:data_min = 0b ;
pflag:data_max = 6b ;
float heading(time) ;
heading:missing_value = 1.e+38f ;
heading:long_name = "Ship heading" ;
heading:units = "degrees" ;
heading:C_format = "%6.1f" ;
heading:data_min = -178.6569f ;
heading:data_max = 176.8997f ;
float tr_temp(time) ;
tr_temp:missing_value = 1.e+38f ;
tr_temp:long_name = "ADCP transducer temperature" ;
tr_temp:units = "Celsius" ;
tr_temp:C_format = "%4.1f" ;
tr_temp:data_min = 26.59908f ;
tr_temp:data_max = 30.64932f ;
short num_pings(time) ;
num_pings:long_name = "Number of pings averaged per ensemble" ;
num_pings:units = "None" ;
num_pings:C_format = "%d" ;
num_pings:data_min = 52s ;
num_pings:data_max = 251s ;
```

```
float uship(time) ;
    uship:missing_value = 1.e+38f ;
    uship:long_name = "Ship zonal velocity component" ;
    uship:units = "meter second-1" ;
    uship:C_format = "%9.4f" ;
    uship:data_min = -6.726838f ;
    uship:data_max = 4.382491f ;
float vship(time) ;
    vship:missing_value = 1.e+38f ;
    vship:long_name = "Ship meridional velocity component" ;
    vship:units = "meter second-1" ;
    vship:C_format = "%9.4f" ;
    vship:data_min = -4.659768f ;
    vship:data_max = 5.268472f ;

// global attributes:
    :featureType = "trajectoryProfile" ;
    :history = "Created: 2022-12-13 02:40:07 UTC" ;
    :Conventions = "COARDS" ;
    :software = "pycurrents" ;
    :hg_changeset = "3211:63370479787a" ;
    :title = "Shipboard ADCP velocity profiles" ;
    :description = "Shipboard ADCP velocity profiles from in2022_v08_pt1 using instrument os150nb
- Short Version." ;
    :cruise_id = "in2022_v08_pt1" ;
    :sonar = "os150nb" ;
    :yearbase = 2022 ;
    :ship_name = "RV_Investigator" ;
    :CODAS_variables = "\n",
        "Variables in this CODAS short-form Netcdf file are intended for most end-user\n",
        "scientific analysis and display purposes. For additional information see\n",
        "the CODAS_processing_note global attribute and the attributes of each\n",
        "of the variables.\n",
        "\n",
        "\n",
        "=====\n",
        "time          Time at the end of the ensemble, days from start of year.\n",
        "lon, lat      Longitude, Latitude from GPS at the end of the ensemble.\n",
        "u,v           Ocean zonal and meridional velocity component profiles.\n",
        "uship, vship  Zonal and meridional velocity components of the ship.\n",
        "heading       Mean ship heading during the ensemble.\n",
        "depth         Bin centers in nominal meters (no sound speed profile correction).\n",
        "tr_temp       ADCP transducer temperature.\n",
        "pg            Percent Good pings for u, v averaging after editing.\n",
        "pflag         Profile Flags based on editing, used to mask u, v.\n",
        "amp           Received signal strength in ADCP-specific units; no correction\n",
        "              for spreading or attenuation.\n",
        "=====\n",
        "\n",
        "" ;
    :CODAS_processing_note = "\n",
        "CODAS processing note:\n",
        "=====\n",
        "\n",
        "Overview\n",
        "-----\n",
        "The CODAS database is a specialized storage format designed for\n",
        "shipboard ADCP data. \"CODAS processing\" uses this format to hold\n",
        "averaged shipboard ADCP velocities and other variables, during the\n",
        "stages of data processing. The CODAS database stores velocity\n",
        "profiles relative to the ship as east and north components along with\n",
        "position, ship speed, heading, and other variables. The netCDF *short*\n",
        "form contains ocean velocities relative to earth, time, position,\n",
        "transducer temperature, and ship heading; these are designed to be\n",
        "\"ready for immediate use\". The netCDF *long* form is just a dump of\n",
        "the entire CODAS database. Some variables are no longer used, and all\n",
        "have names derived from their original CODAS names, dating back to the\n",
        "late 1980's.\n",
        "\n",
        "Post-processing\n",
        "-----\n",
        "CODAS post-processing, i.e. that which occurs after the single-ping\n",
        "profiles have been vector-averaged and loaded into the CODAS database,\n",
        "includes editing (using automated algorithms and manual tools),\n
```

```

"rotation and scaling of the measured velocities, and application of a\n",
"time-varying heading correction. Additional algorithms developed more\n",
"recently include translation of the GPS positions to the transducer\n",
"location, and averaging of ship\'s speed over the times of valid pings\n",
"when Percent Good is reduced. Such post-processing is needed prior to\n",
"submission of \"processed ADCP data\" to JASADCP or other archives.\n",
"\n",
"Full CODAS processing\n",
"-----\n",
"Whenever single-ping data have been recorded, full CODAS processing\n",
"provides the best end product.\n",
"\n",
"Full CODAS processing starts with the single-ping velocities in beam\n",
"coordinates. Based on the transducer orientation relative to the\n",
"hull, the beam velocities are transformed to horizontal, vertical, and\n",
"\"error velocity\" components. Using a reliable heading (typically from\n",
"the ship\'s gyro compass), the velocities in ship coordinates are\n",
"rotated into earth coordinates.\n",
"\n",
"Pings are grouped into an \"ensemble\" (usually 2-5 minutes duration)\n",
"and undergo a suite of automated editing algorithms (removal of\n",
"acoustic interference; identification of the bottom; editing based on\n",
"thresholds; and specialized editing that targets CTD wire interference\n",
"and \"weak, biased profiles\". The ensemble of single-ping velocities\n",
"is then averaged using an iterative reference layer averaging scheme.\n",
Each ensemble is approximated as a single function of depth, with a\n",
zero-average over a reference layer plus a reference layer velocity\n",
for each ping. Adding the average of the single-ping reference layer\n",
velocities to the function of depth yields the ensemble-average\n",
velocity profile. These averaged profiles, along with ancillary\n",
measurements, are written to disk, and subsequently loaded into the\n",
CODAS database. Everything after this stage is \"post-processing\".\n",
"\n",
"note (time):\n",
"-----\n",
"Time is stored in the database using UTC Year, Month, Day, Hour,\n",
"Minute, Seconds. Floating point time \"Decimal Day\" is the floating\n",
"point interval in days since the start of the year, usually the year\n",
"of the first day of the cruise.\n",
"\n",
"\n",
"note (heading):\n",
"-----\n",
"CODAS processing uses heading from a reliable device, and (if\n",
available) uses a time-dependent correction by an accurate heading\n",
device. The reliable heading device is typically a gyro compass (for\n",
example, the Bridge gyro). Accurate heading devices can be POSMV,\n",
Seapath, Phins, Hydrins, MAHRS, or various Ashtech devices; this\n",
varies with the technology of the time. It is always confusing to\n",
keep track of the sign of the heading correction. Headings are written\n",
degrees, positive clockwise. setting up some variables:\n",
"\n",
"X = transducer angle (CONFIG1_heading_bias)\n",
"    positive clockwise (beam 3 angle relative to ship)\n",
"G = Reliable heading (gyrocompass)\n",
"A = Accurate heading\n",
"dh = G - A = time-dependent heading correction (ANCIL2_watr_k_hd_misalign)\n",
"\n",
"Rotation of the measured velocities into the correct coordinate system\n",
amounts to (u+i*v)*(exp(i*theta)) where theta is the sum of the\n",
corrected heading and the transducer angle.\n",
"\n",
"theta = X + (G - dh) = X + G - dh\n",
"\n",
"\n",
"Watertrack and Bottomtrack calibrations give an indication of the\n",
residual angle offset to apply, for example if mean and median of the\n",
phase are all 0.5 (then R=0.5). Using the \"rotate\" command,\n",
the value of R is added to \"ANCIL2_watr_k_hd_misalign\".\n",
"\n",
"new_dh = dh + R\n",
"\n",
"Therefore the total angle used in rotation is\n",
"\n",

```

```

"new_theta = X + G - dh_new\n",
"          = X + G - (dh + R)\n",
"          = (X - R) + (G - dh)\n",
"\n",
"The new estimate of the transducer angle is: X - R\n",
"ANCIL2_watrk_hd_misalign contains: dh + R\n",
"\n",
"=====\n",
"\n",
"Profile flags\n",
"-----\n",
"Profile editing flags are provided for each depth cell:\n",
"\n",
"binary      decimal      below      Percent\n",
"value       value       bottom     Good       bin\n",
"-----+-----+-----+-----+-----+\n",
"000          0\n",
"001          1\n",
"010          2\n",
"011          3\n",
"100          4\n",
"101          5\n",
"110          6\n",
"111          7\n",
"-----+-----+-----+-----+-----+\n",
"" ;
}

```

4.3 OS75nb Part-2:

```

codaspy:(os75nb)$ ncdump -h in2022_v08_os75nb_pt2.nc
netcdf in2022_v08_os75nb_pt2 {
dimensions:
    time = 6003 ;
    depth_cell = 60 ;
variables:
    int trajectory ;
        trajectory:standard_name = "trajectory_id" ;
    double time(time) ;
        time:long_name = "Decimal day" ;
        time:units = "days since 2022-01-01 00:00:00" ;
        time:C_format = "%12.5f" ;
        time:standard_name = "time" ;
        time:data_min = 282.01847222222 ;
        time:data_max = 305.805451388889 ;
    double lon(time) ;
        lon:missing_value = 1.e+38 ;
        lon:long_name = "Longitude" ;
        lon:units = "degrees_east" ;
        lon:C_format = "%9.4f" ;
        lon:standard_name = "longitude" ;
        lon:data_min = 95.233352777778 ;
        lon:data_max = 115.21501388889 ;
    double lat(time) ;
        lat:missing_value = 1.e+38 ;
        lat:long_name = "Latitude" ;
        lat:units = "degrees_north" ;
        lat:C_format = "%9.4f" ;
        lat:standard_name = "latitude" ;
        lat:data_min = -31.99925 ;
        lat:data_max = -10.482636111111 ;
    float depth(time, depth_cell) ;
        depth:missing_value = 1.e+38f ;
        depth:long_name = "Depth" ;
        depth:units = "meter" ;
        depth:C_format = "%8.2f" ;
        depth:positive = "down" ;
        depth:data_min = 29.99f ;
        depth:data_max = 973.99f ;
    float u(time, depth_cell) ;

```

```

    u:missing_value = 1.e+38f ;
    u:long_name = "Zonal velocity component" ;
    u:units = "meter second-1" ;
    u:C_format = "%7.2f" ;
    u:data_min = -1.037788f ;
    u:data_max = 1.319704f ;
float v(time, depth_cell) ;
    v:missing_value = 1.e+38f ;
    v:long_name = "Meridional velocity component" ;
    v:units = "meter second-1" ;
    v:C_format = "%7.2f" ;
    v:data_min = -1.022444f ;
    v:data_max = 0.72966f ;
short amp(time, depth_cell) ;
    amp:missing_value = 32767s ;
    amp:long_name = "Received signal strength" ;
    amp:C_format = "%d" ;
    amp:data_min = 22s ;
    amp:data_max = 185s ;
byte pg(time, depth_cell) ;
    pg:missing_value = -1b ;
    pg:long_name = "Percent good pings" ;
    pg:C_format = "%d" ;
    pg:data_min = 0b ;
    pg:data_max = 100b ;
byte pflag(time, depth_cell) ;
    pflag:long_name = "Editing flags" ;
    pflag:C_format = "%d" ;
    pflag:data_min = 0b ;
    pflag:data_max = 6b ;
float heading(time) ;
    heading:missing_value = 1.e+38f ;
    heading:long_name = "Ship heading" ;
    heading:units = "degrees" ;
    heading:C_format = "%6.1f" ;
    heading:data_min = -179.9333f ;
    heading:data_max = 179.9913f ;
float tr_temp(time) ;
    tr_temp:missing_value = 1.e+38f ;
    tr_temp:long_name = "ADCP transducer temperature" ;
    tr_temp:units = "Celsius" ;
    tr_temp:C_format = "%4.1f" ;
    tr_temp:data_min = 19.08729f ;
    tr_temp:data_max = 28.24075f ;
short num_pings(time) ;
    num_pings:long_name = "Number of pings averaged per ensemble" ;
    num_pings:units = "None" ;
    num_pings:C_format = "%d" ;
    num_pings:data_min = 20s ;
    num_pings:data_max = 133s ;
float uship(time) ;
    uship:missing_value = 1.e+38f ;
    uship:long_name = "Ship zonal velocity component" ;
    uship:units = "meter second-1" ;
    uship:C_format = "%9.4f" ;
    uship:data_min = -6.050996f ;
    uship:data_max = 5.19318f ;
float vship(time) ;
    vship:missing_value = 1.e+38f ;
    vship:long_name = "Ship meridional velocity component" ;
    vship:units = "meter second-1" ;
    vship:C_format = "%9.4f" ;
    vship:data_min = -5.401468f ;
    vship:data_max = 5.168765f ;

// global attributes:
    :featureType = "trajectoryProfile" ;
    :history = "Created: 2022-12-13 00:40:14 UTC" ;
    :Conventions = "COARDS" ;
    :software = "pycurrents" ;
    :hg_changeset = "3211:63370479787a" ;
    :title = "Shipboard ADCP velocity profiles" ;
    :description = "Shipboard ADCP velocity profiles from in2022_v08_pt2 using instrument os75nb
- Short Version." ;
```

```
:cruise_id = "in2022_v08_pt2" ;
:sonar = "os75nb" ;
:yearbase = 2022 ;
:ship_name = "RV_Investigator" ;
:CODAS_variables = "\n",
    "Variables in this CODAS short-form Netcdf file are intended for most end-user\n",
    "scientific analysis and display purposes. For additional information see\n",
    "the CODAS_processing_note global attribute and the attributes of each\n",
    "of the variables.\n",
    "\n",
    "\n",
    "=====\n",
    "time          Time at the end of the ensemble, days from start of year.\n",
    "lon, lat      Longitude, Latitude from GPS at the end of the ensemble.\n",
    "u,v          Ocean zonal and meridional velocity component profiles.\n",
    "uship, vship  Zonal and meridional velocity components of the ship.\n",
    "heading       Mean ship heading during the ensemble.\n",
    "depth        Bin centers in nominal meters (no sound speed profile correction).\n",
    "tr_temp      ADCP transducer temperature.\n",
    "pg           Percent Good pings for u, v averaging after editing.\n",
    "pflag        Profile Flags based on editing, used to mask u, v.\n",
    "amp          Received signal strength in ADCP-specific units; no correction\n",
    "              for spreading or attenuation.\n",
    "=====\n",
    "\n",
    "" ;
:CODAS_processing_note = "\n",
    "CODAS processing note:\n",
    "=====\n",
    "\n",
    "Overview\n",
    "-----\n",
    "The CODAS database is a specialized storage format designed for\n",
    "shipboard ADCP data. \"CODAS processing\" uses this format to hold\n",
    "averaged shipboard ADCP velocities and other variables, during the\n",
    "stages of data processing. The CODAS database stores velocity\n",
    "profiles relative to the ship as east and north components along with\n",
    "position, ship speed, heading, and other variables. The netCDF *short*\n",
    "form contains ocean velocities relative to earth, time, position,\n",
    "transducer temperature, and ship heading; these are designed to be\n",
    "\"ready for immediate use\". The netCDF *long* form is just a dump of\n",
    "the entire CODAS database. Some variables are no longer used, and all\n",
    "have names derived from their original CODAS names, dating back to the\n",
    "late 1980's.\n",
    "\n",
    "Post-processing\n",
    "-----\n",
    "CODAS post-processing, i.e. that which occurs after the single-ping\n",
    "profiles have been vector-averaged and loaded into the CODAS database,\n",
    "includes editing (using automated algorithms and manual tools),\n",
    "rotation and scaling of the measured velocities, and application of a\n",
    "time-varying heading correction. Additional algorithms developed more\n",
    "recently include translation of the GPS positions to the transducer\n",
    "location, and averaging of ship's speed over the times of valid pings\n",
    "when Percent Good is reduced. Such post-processing is needed prior to\n",
    "submission of \"processed ADCP data\" to JASADCP or other archives.\n",
    "\n",
    "Full CODAS processing\n",
    "-----\n",
    "Whenever single-ping data have been recorded, full CODAS processing\n",
    "provides the best end product.\n",
    "\n",
    "Full CODAS processing starts with the single-ping velocities in beam\n",
    "coordinates. Based on the transducer orientation relative to the\n",
    "hull, the beam velocities are transformed to horizontal, vertical, and\n",
    "\"error velocity\" components. Using a reliable heading (typically from\n",
    "the ship's gyro compass), the velocities in ship coordinates are\n",
    "rotated into earth coordinates.\n",
    "\n",
    "Pings are grouped into an \"ensemble\" (usually 2-5 minutes duration)\n",
    "and undergo a suite of automated editing algorithms (removal of\n",
    "acoustic interference; identification of the bottom; editing based on\n",
    "thresholds; and specialized editing that targets CTD wire interference\n",
    "and \"weak, biased profiles\". The ensemble of single-ping velocities
```

```

"is then averaged using an iterative reference layer averaging scheme.\n",
"Each ensemble is approximated as a single function of depth, with a\n",
"zero-average over a reference layer plus a reference layer velocity\n",
"for each ping. Adding the average of the single-ping reference layer\n",
"velocities to the function of depth yields the ensemble-average\n",
"velocity profile. These averaged profiles, along with ancillary\n",
"measurements, are written to disk, and subsequently loaded into the\n",
"CODAS database. Everything after this stage is \"post-processing\".\n",
"\n",
"note (time):\n",
"-----\n",
"Time is stored in the database using UTC Year, Month, Day, Hour,\n",
"Minute, Seconds. Floating point time \"Decimal Day\" is the floating\n",
"point interval in days since the start of the year, usually the year\n",
"of the first day of the cruise.\n",
"\n",
"\n",
"note (heading):\n",
"-----\n",
"CODAS processing uses heading from a reliable device, and (if\n",
"available) uses a time-dependent correction by an accurate heading\n",
"device. The reliable heading device is typically a gyro compass (for\n",
"example, the Bridge gyro). Accurate heading devices can be POSMV,\n",
"Seapath, Phins, Hydrins, MAHRS, or various Ashtech devices; this\n",
"varies with the technology of the time. It is always confusing to\n",
"keep track of the sign of the heading correction. Headings are written\n",
"degrees, positive clockwise. setting up some variables:\n",
"\n",
"X = transducer angle (CONFIG1_heading_bias)\n",
"    positive clockwise (beam 3 angle relative to ship)\n",
"G = Reliable heading (gyrocompass)\n",
"A = Accurate heading\n",
"dh = G - A = time-dependent heading correction (ANCIL2_watrk_hd_misalign)\n",
"\n",
"Rotation of the measured velocities into the correct coordinate system\n",
"amounts to (u+i*v)*(exp(i*theta)) where theta is the sum of the\n",
"corrected heading and the transducer angle.\n",
"\n",
"theta = X + (G - dh) = X + G - dh\n",
"\n",
"\n",
"Watertrack and Bottomtrack calibrations give an indication of the\n",
"residual angle offset to apply, for example if mean and median of the\n",
"phase are all 0.5 (then R=0.5). Using the \"rotate\" command,\n",
"the value of R is added to \"ANCIL2_watrk_hd_misalign\".\n",
"\n",
"new_dh = dh + R\n",
"\n",
"Therefore the total angle used in rotation is\n",
"\n",
"new_theta = X + G - dh_new\n",
"            = X + G - (dh + R)\n",
"            = (X - R) + (G - dh)\n",
"\n",
"The new estimate of the transducer angle is: X - R\n",
"ANCIL2_watrk_hd_misalign contains: dh + R\n",
"\n",
"=====\n",
"\n",
"Profile flags\n",
"-----\n",
"Profile editing flags are provided for each depth cell:\n",
"\n",


| binary | decimal | below  | Percent |     |
|--------|---------|--------|---------|-----|
| value  | value   | bottom | Good    | bin |
| 000    | 0       |        |         |     |
| 001    | 1       |        |         | bad |
| 010    | 2       |        | bad     |     |
| 011    | 3       |        | bad     | bad |
| 100    | 4       | bad    |         |     |
| 101    | 5       | bad    |         | bad |
| 110    | 6       | bad    | bad     |     |
| 111    | 7       | bad    | bad     | bad |


```



```
        "-----+-----+-----+-----+-----+\n",  
        "" ;  
}
```

4.4 OS150nb Part-2:

```
codaspy:(os150nb)$ ncdump -h in2022_v08_os150nb_pt2.nc  
netcdf in2022_v08_os150nb_pt2 {  
  dimensions:  
    time = 6922 ;  
    depth_cell = 60 ;  
  variables:  
    int trajectory ;  
        trajectory:standard_name = "trajectory_id" ;  
    double time(time) ;  
        time:long_name = "Decimal day" ;  
        time:units = "days since 2022-01-01 00:00:00" ;  
        time:C_format = "%12.5f" ;  
        time:standard_name = "time" ;  
        time:data_min = 282.01847222222 ;  
        time:data_max = 306.05743055556 ;  
    double lon(time) ;  
        lon:missing_value = 1.e+38 ;  
        lon:long_name = "Longitude" ;  
        lon:units = "degrees_east" ;  
        lon:C_format = "%9.4f" ;  
        lon:standard_name = "longitude" ;  
        lon:data_min = 95.233330555556 ;  
        lon:data_max = 115.70400555556 ;  
    double lat(time) ;  
        lat:missing_value = 1.e+38 ;  
        lat:long_name = "Latitude" ;  
        lat:units = "degrees_north" ;  
        lat:C_format = "%9.4f" ;  
        lat:standard_name = "latitude" ;  
        lat:data_min = -32.175388888889 ;  
        lat:data_max = -10.482630555556 ;  
    float depth(time, depth_cell) ;  
        depth:missing_value = 1.e+38f ;  
        depth:long_name = "Depth" ;  
        depth:units = "meter" ;  
        depth:C_format = "%8.2f" ;  
        depth:positive = "down" ;  
        depth:data_min = 17.93f ;  
        depth:data_max = 490.f ;  
    float u(time, depth_cell) ;  
        u:missing_value = 1.e+38f ;  
        u:long_name = "Zonal velocity component" ;  
        u:units = "meter second-1" ;  
        u:C_format = "%7.2f" ;  
        u:data_min = -1.077676f ;  
        u:data_max = 1.339009f ;  
    float v(time, depth_cell) ;  
        v:missing_value = 1.e+38f ;  
        v:long_name = "Meridional velocity component" ;  
        v:units = "meter second-1" ;  
        v:C_format = "%7.2f" ;  
        v:data_min = -1.019558f ;  
        v:data_max = 0.771426f ;  
    short amp(time, depth_cell) ;  
        amp:missing_value = 32767s ;  
        amp:long_name = "Received signal strength" ;  
        amp:C_format = "%d" ;  
        amp:data_min = 21s ;  
        amp:data_max = 229s ;  
    byte pg(time, depth_cell) ;  
        pg:missing_value = -1b ;  
        pg:long_name = "Percent good pings" ;  
        pg:C_format = "%d" ;  
        pg:data_min = 0b ;  
        pg:data_max = 100b ;
```

```
byte pflag(time, depth_cell) ;
    pflag:long_name = "Editing flags" ;
    pflag:C_format = "%d" ;
    pflag:data_min = 0b ;
    pflag:data_max = 6b ;
float heading(time) ;
    heading:missing_value = 1.e+38f ;
    heading:long_name = "Ship heading" ;
    heading:units = "degrees" ;
    heading:C_format = "%6.1f" ;
    heading:data_min = -179.6922f ;
    heading:data_max = 179.9377f ;
float tr_temp(time) ;
    tr_temp:missing_value = 1.e+38f ;
    tr_temp:long_name = "ADCP transducer temperature" ;
    tr_temp:units = "Celsius" ;
    tr_temp:C_format = "%4.1f" ;
    tr_temp:data_min = 18.37879f ;
    tr_temp:data_max = 28.68814f ;
short num_pings(time) ;
    num_pings:long_name = "Number of pings averaged per ensemble" ;
    num_pings:units = "None" ;
    num_pings:C_format = "%d" ;
    num_pings:data_min = 108s ;
    num_pings:data_max = 251s ;
float uship(time) ;
    uship:missing_value = 1.e+38f ;
    uship:long_name = "Ship zonal velocity component" ;
    uship:units = "meter second-1" ;
    uship:C_format = "%9.4f" ;
    uship:data_min = -6.049657f ;
    uship:data_max = 5.195506f ;
float vship(time) ;
    vship:missing_value = 1.e+38f ;
    vship:long_name = "Ship meridional velocity component" ;
    vship:units = "meter second-1" ;
    vship:C_format = "%9.4f" ;
    vship:data_min = -5.505482f ;
    vship:data_max = 5.166459f ;

// global attributes:
:featureType = "trajectoryProfile" ;
:history = "Created: 2022-12-13 00:42:04 UTC" ;
:Conventions = "COARDS" ;
:software = "pycurrents" ;
:hg_changeset = "3211:63370479787a" ;
:title = "Shipboard ADCP velocity profiles" ;
:description = "Shipboard ADCP velocity profiles from in2022_v08_pt2 using instrument os150nb
- Short Version." ;
:cruise_id = "in2022_v08_pt2" ;
:sonar = "os150nb" ;
:yearbase = 2022 ;
:ship_name = "RV_Investigator" ;
:CODAS_variables = "\n",
    "Variables in this CODAS short-form Netcdf file are intended for most end-user\n",
    "scientific analysis and display purposes. For additional information see\n",
    "the CODAS_processing_note global attribute and the attributes of each\n",
    "of the variables.\n",
    "\n",
    "\n",
    "=====\n",
    "time      Time at the end of the ensemble, days from start of year.\n",
    "lon, lat  Longitude, Latitude from GPS at the end of the ensemble.\n",
    "u,v       Ocean zonal and meridional velocity component profiles.\n",
    "uship, vship  Zonal and meridional velocity components of the ship.\n",
    "heading   Mean ship heading during the ensemble.\n",
    "depth     Bin centers in nominal meters (no sound speed profile correction).\n",
    "tr_temp   ADCP transducer temperature.\n",
    "pg        Percent Good pings for u, v averaging after editing.\n",
    "pflag     Profile Flags based on editing, used to mask u, v.\n",
    "amp       Received signal strength in ADCP-specific units; no correction\n",
    "          for spreading or attenuation.\n",
    "=====\n",
    "\n",
```

```

"" ;
:CODAS_processing_note = "\n",
"CODAS processing note:\n",
"=====\n",
"\n",
"Overview\n",
"-----\n",
"The CODAS database is a specialized storage format designed for\n",
"shipboard ADCP data. \"CODAS processing\" uses this format to hold\n",
"averaged shipboard ADCP velocities and other variables, during the\n",
"stages of data processing. The CODAS database stores velocity\n",
"profiles relative to the ship as east and north components along with\n",
"position, ship speed, heading, and other variables. The netCDF *short*\n",
"form contains ocean velocities relative to earth, time, position,\n",
"transducer temperature, and ship heading; these are designed to be\n",
"\"ready for immediate use\". The netCDF *long* form is just a dump of\n",
"the entire CODAS database. Some variables are no longer used, and all\n",
"have names derived from their original CODAS names, dating back to the\n",
"late 1980's.\n",
"\n",
"Post-processing\n",
"-----\n",
"CODAS post-processing, i.e. that which occurs after the single-ping\n",
"profiles have been vector-averaged and loaded into the CODAS database,\n",
"includes editing (using automated algorithms and manual tools),\n",
"rotation and scaling of the measured velocities, and application of a\n",
"time-varying heading correction. Additional algorithms developed more\n",
"recently include translation of the GPS positions to the transducer\n",
"location, and averaging of ship's speed over the times of valid pings\n",
"when Percent Good is reduced. Such post-processing is needed prior to\n",
"submission of \"processed ADCP data\" to JASADCP or other archives.\n",
"\n",
"Full CODAS processing\n",
"-----\n",
"Whenever single-ping data have been recorded, full CODAS processing\n",
"provides the best end product.\n",
"\n",
"Full CODAS processing starts with the single-ping velocities in beam\n",
"coordinates. Based on the transducer orientation relative to the\n",
"hull, the beam velocities are transformed to horizontal, vertical, and\n",
"\"error velocity\" components. Using a reliable heading (typically from\n",
"the ship's gyro compass), the velocities in ship coordinates are\n",
"rotated into earth coordinates.\n",
"\n",
"Pings are grouped into an \"ensemble\" (usually 2-5 minutes duration)\n",
"and undergo a suite of automated editing algorithms (removal of\n",
"acoustic interference; identification of the bottom; editing based on\n",
"thresholds; and specialized editing that targets CTD wire interference\n",
"and \"weak, biased profiles\". The ensemble of single-ping velocities\n",
"is then averaged using an iterative reference layer averaging scheme.\n",
"Each ensemble is approximated as a single function of depth, with a\n",
"zero-average over a reference layer plus a reference layer velocity\n",
"for each ping. Adding the average of the single-ping reference layer\n",
"velocities to the function of depth yields the ensemble-average\n",
"velocity profile. These averaged profiles, along with ancillary\n",
"measurements, are written to disk, and subsequently loaded into the\n",
"CODAS database. Everything after this stage is \"post-processing\".\n",
"\n",
"note (time):\n",
"-----\n",
"Time is stored in the database using UTC Year, Month, Day, Hour,\n",
"Minute, Seconds. Floating point time \"Decimal Day\" is the floating\n",
"point interval in days since the start of the year, usually the year\n",
"of the first day of the cruise.\n",
"\n",
"note (heading):\n",
"-----\n",
"CODAS processing uses heading from a reliable device, and (if\n",
"available) uses a time-dependent correction by an accurate heading\n",
"device. The reliable heading device is typically a gyro compass (for\n",
"example, the Bridge gyro). Accurate heading devices can be POSMV,\n",
"Seapath, Phins, Hydrins, MAHRS, or various Ashtech devices; this\n",
"varies with the technology of the time. It is always confusing to\n",

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"keep track of the sign of the heading correction. Headings are written\n",
"degrees, positive clockwise. setting up some variables:\n",
"\n",
"X = transducer angle (CONFIG1_heading_bias)\n",
"    positive clockwise (beam 3 angle relative to ship)\n",
"G = Reliable heading (gyrocompass)\n",
"A = Accurate heading\n",
"dh = G - A = time-dependent heading correction (ANCIL2_watr_k_hd_misalign)\n",
"\n",
"Rotation of the measured velocities into the correct coordinate system\n",
"amounts to (u+i*v)*(exp(i*theta)) where theta is the sum of the\n",
"corrected heading and the transducer angle.\n",
"\n",
"theta = X + (G - dh) = X + G - dh\n",
"\n",
"\n",
"Watertrack and Bottomtrack calibrations give an indication of the\n",
"residual angle offset to apply, for example if mean and median of the\n",
"phase are all 0.5 (then R=0.5). Using the \"rotate\" command,\n",
"the value of R is added to \"ANCIL2_watr_k_hd_misalign\".\n",
"\n",
"new_dh = dh + R\n",
"\n",
"Therefore the total angle used in rotation is\n",
"\n",
"new_theta = X + G - dh_new\n",
"            = X + G - (dh + R)\n",
"            = (X - R) + (G - dh)\n",
"\n",
"The new estimate of the transducer angle is: X - R\n",
"ANCIL2_watr_k_hd_misalign contains: dh + R\n",
"\n",
"=====\n",
"\n",
"Profile flags\n",
"-----\n",
"Profile editing flags are provided for each depth cell:\n",
"\n",


| binary | decimal | below  | Percent |     |
|--------|---------|--------|---------|-----|
| value  | value   | bottom | Good    | bin |
| 000    | 0       |        |         |     |
| 001    | 1       |        |         | bad |
| 010    | 2       |        | bad     |     |
| 011    | 3       |        | bad     | bad |
| 100    | 4       | bad    |         |     |
| 101    | 5       | bad    |         | bad |
| 110    | 6       | bad    | bad     |     |
| 111    | 7       | bad    | bad     | bad |


```

}