

## RV Investigator

### ADCP Processing Report

|                         |   |
|-------------------------|---|
| <b>Voyage:</b>          | IN2022_V06  |
| <b>Voyage title:</b>    | Integrated Marine Observing System: monitoring of East Australian Current property transports at 27 degrees South |
| <b>Depart:</b>          | Brisbane, 1015 AEST 14 July 2022  |
| <b>Return:</b>          | Brisbane, 0830 AEST 30 July 2022  |
| <b>Chief Scientist:</b> | Sloyan (IMOS) / Chapman (CSIRO)   |
| <b>Data Processor</b>   | Vito Dirita (CSIRO – E&T Data Acquisition and Processing)   |

### Document History

| Date        | Version | Author                         | Comments                       |
|-------------|---------|--------------------------------|--------------------------------|
| 02 Aug 2022 | 1.0     | Stephanie Petillo              | Initial Template Version       |
| 27 Oct 2022 | 1.1     | Vito Dirita                    | Draft Version (to be reviewed) |
| 31 Oct 2022 | 1.2     | Vito Dirita, Stephanie Petillo | Final Release Version          |



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## 1 Summary

The ADCP was run for most of the voyage, though it was turned off when EK80 surveys were being performed to avoid creating interference in the EK80 data. 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](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.

Internal triggering was used.

The drop keel was at 7 m below the waterline for the duration of the voyage.

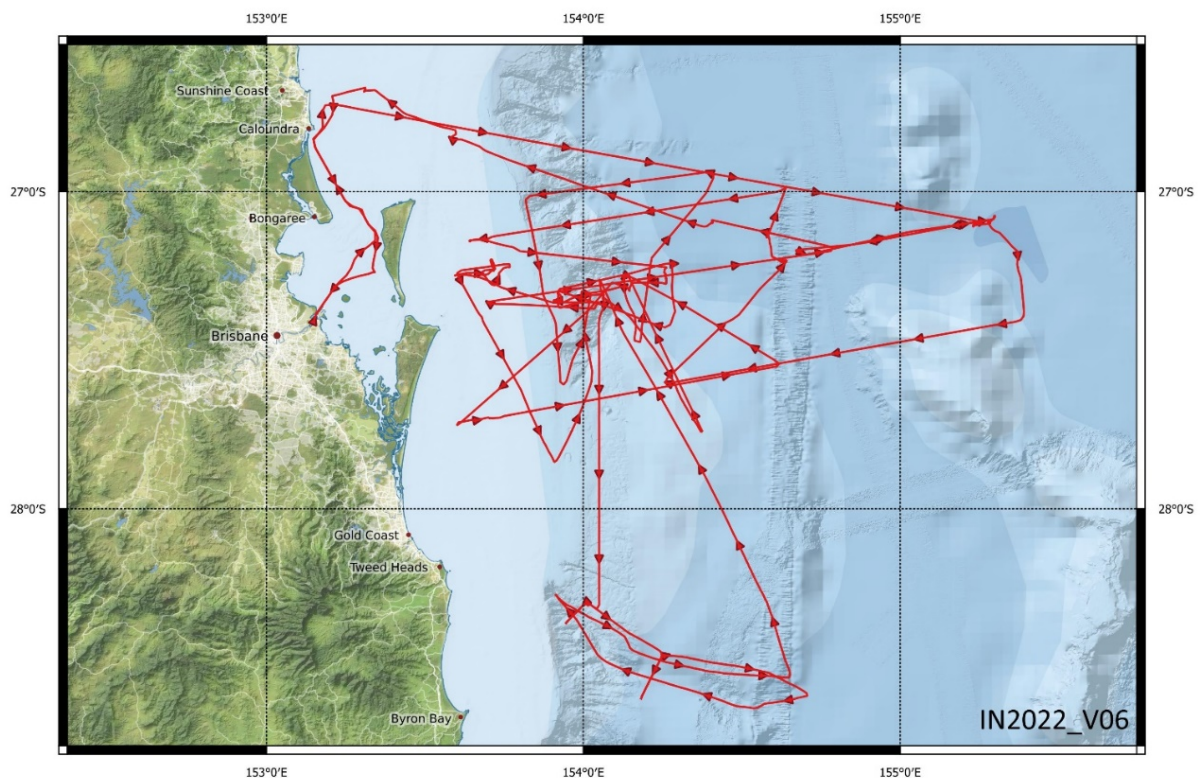
See the voyage computing and electronics report for more details regarding data acquisition.

## 2 Voyage Details

### 2.1 Voyage Objectives

The key objective of the voyage was to recover six moorings situated in the East Australian Current Qld region. The mooring arrays were located near the existing long-term XBT transect and satellite altimetry ground tracks. The aim of this observing system is to capture the mean and time-varying flow of the EAC.

### 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

During the first part of the voyage, the POSMV was outputting frequent errors, the heading was subsequently changed to run from Seapath, consequently, the data has been divided into two sets as follows:

part-1: 14-Jul-2022 05:38 - 21-Jul-2022 02:54 (UTC)  
part-2: 21-Jul-2022 03:07 - 27-Jul-2022 20:51 (UTC)

Only minor editing was required, data was masked where instrument anomalies were suspected and where the os75 and os150 data differed significantly. A heading correction was applied to both ADCPs using `patch_hcorr.py` using water track and bottom track:

Amplitude and phase rotation corrections applied:

|         | OS75      |        | OS150     |        |
|---------|-----------|--------|-----------|--------|
|         | Amplitude | Phase  | Amplitude | Phase  |
| Part-1: | 0.9979    | 0.0343 | 1.0031    | 0.0320 |
| Part-2  | 1.0025    | 0.2335 | 1.0080    | 0.0440 |

Table.1

Final OS75 and OS150 amplitude and phase:

|         | OS75      |        | OS150     |         |
|---------|-----------|--------|-----------|---------|
|         | Amplitude | Phase  | Amplitude | Phase   |
| Part-1: | 1.0000    | 0.0101 | 0.9998    | 0.0014  |
| Part-2  | 1.0000    | 0.0020 | 1.0000    | -0.0530 |

Table.2

It was not possible to use bottom-track calibration for the second part of the voyage. When processing the data, the true transducer offsets in metres from the GPS position of the ship in (meters) are as follows for both part-1 and part-2 of the voyage:

| OS75   |        | OS150  |        |
|--------|--------|--------|--------|
| dx (m) | dy (m) | dx (m) | dy (m) |
| -1.0   | 4.0    | -1.0   | 1.0    |

Table.3

## 4 netCDF Data Headers

### PART-1 OF VOYAGE

#### 4.1 OS75nb (Part-1)

```
ncdump -h in2022_v06_os75nb.nc
netcdf in2022_v06_os75nb {
dimensions:
    time = 1771 ;
    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 = 194.234722222222 ;
        time:data_max = 201.121273148148 ;
    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 = 153.416113888889 ;
        lon:data_max = 156.659980555556 ;
    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 = -28.4278833333333 ;
        lat:data_max = -26.7618444444444 ;
    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 = -0.7606382f ;
        u:data_max = 0.5625259f ;
    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 = -1.259327f ;
        v:data_max = 0.7812526f ;
    short amp(time, depth_cell) ;
        amp:missing_value = 32767s ;
        amp:long_name = "Received signal strength" ;
        amp:C_format = "%d" ;
        amp:data_min = 24s ;
        amp:data_max = 217s ;
    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 = -179.6924f ;
    heading:data_max = 179.5943f ;
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 = 19.61108f ;
    tr_temp:data_max = 23.99967f ;
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 = 11s ;
    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 = -398.8306f ;
    uship:data_max = 48.82794f ;
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 = -5.08479f ;
    vship:data_max = 4.535328f ;

// global attributes:
:featureType = "trajectoryProfile" ;
:history = "Created: 2022-10-25 04:34:38 UTC" ;
:Conventions = "COARDS" ;
:software = "pycurrents" ;
:hg_changeset = "3211:63370479787a" ;
:title = "Shipboard ADCP velocity profiles" ;
:description = "Shipboard ADCP velocity profiles from in2022_v06 using instrument os75nb -
Short Version." ;
:cruise_id = "in2022_v06" ;
: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",
    "=====" ,
    "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
```

```
"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_watrkh_d_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_d_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_d_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                               bad\n",
"010        2                               bad\n",
"011        3                               bad\n",
"100        4          bad\n",
"101        5          bad                               bad\n",
"110        6          bad          bad\n",
"111        7          bad          bad          bad\n",
"-----+-----+-----+-----+\n",
"" ;
}
```

## 4.2 OS150nb (Part-1)

```
codaspy:(os150nb)$ ncdump -h in2022_v06_os150nb.nc
netcdf in2022_v06_os150nb {
dimensions:
    time = 1772 ;
    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 = 194.234699074074 ;
        time:data_max = 201.121273148148 ;
```



```
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 = 153.415944444444 ;
    lon:data_max = 156.660058333333 ;
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 = -28.427875 ;
    lat:data_max = -26.7618111111111 ;
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 = 489.98f ;
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 = -0.694911f ;
    u:data_max = 0.5745742f ;
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 = -1.258736f ;
    v:data_max = 0.4160528f ;
short amp(time, depth_cell) ;
    amp:missing_value = 32767s ;
    amp:long_name = "Received signal strength" ;
    amp:C_format = "%d" ;
    amp:data_min = 23s ;
    amp:data_max = 225s ;
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 = -179.6255f ;
    heading:data_max = 179.5948f ;
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 = 19.60756f ;
    tr_temp:data_max = 23.3552f ;
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 = 16s ;
```

```
        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 = -346.5154f ;
    uship:data_max = 49.11211f ;
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 = -5.089586f ;
    vship:data_max = 4.536681f ;

// global attributes:
:featureType = "trajectoryProfile" ;
:history = "Created: 2022-10-25 04:38:52 UTC" ;
:Conventions = "COARDS" ;
:software = "pycurrents" ;
:hg_changeset = "3211:63370479787a" ;
:title = "Shipboard ADCP velocity profiles" ;
:description = "Shipboard ADCP velocity profiles from in2022_v06 using instrument os150nb -
Short Version." ;
:cruise_id = "in2022_v06" ;
: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  $(u+iv) * (\exp(i * \theta))$  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                               bad\n",
"010       2                               bad\n",
"011       3                               bad\n",
"100       4          bad\n",
"101       5          bad                               bad\n",
"110       6          bad          bad\n",
"111       7          bad          bad          bad\n",
"-----+-----+-----+-----+\n",
"" ;
}
```

## **PART-2 OF VOYAGE**

### **4.3 OS75nb (Part-2)**

```
codaspy:(os75nb)$ ncdump -h in2022_v06_os75nb.nc
netcdf in2022_v06_os75nb {
dimensions:
    time = 1736 ;
    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 = 201.130138888889 ;
        time:data_max = 207.868587962963 ;
    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 = 153.307483333333 ;
        lon:data_max = 154.785438888889 ;
    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 = -28.6294694444444 ;
        lat:data_max = -26.6761055555556 ;
    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 = -1.066649f ;
    u:data_max = 1.017711f ;
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 = -1.012003f ;
    v:data_max = 0.2787921f ;
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 = 217s ;
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 = -179.2155f ;
    heading:data_max = 179.3919f ;
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 = 20.41712f ;
    tr_temp:data_max = 22.65316f ;
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 = 35s ;
    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 = -5.683346f ;
    uship:data_max = 4.682076f ;
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 = -4.601793f ;
    vship:data_max = 5.637966f ;

// global attributes:
:featureType = "trajectoryProfile" ;
:history = "Created: 2022-10-26 00:02:38 UTC" ;
:Conventions = "COARDS" ;
:software = "pycurrents" ;
:hg_changeset = "3211:63370479787a" ;
```

```
:title = "Shipboard ADCP velocity profiles" ;
:description = "Shipboard ADCP velocity profiles from in2022_v06 using instrument os75nb -
Short Version." ;
:cruise_id = "in2022_v06" ;
: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",  
"\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  $(u+iv) * (\exp(i * \theta))$  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\n",  
"value value bottom Good bin\n",  
"-----+-----+-----+-----+\n",  
"000 0\n",  
"001 1 bad\n",  
"010 2 bad\n",  
"011 3 bad bad\n",  
"100 4 bad

```
"101      5      bad      bad\n",  
"110      6      bad      bad\n",  
"111      7      bad      bad\n",  
"-----+-----+-----+-----+-----+\n",  
"" ;  
}
```

#### 4.4 OS150nb (Part-2)

```
codaspy:(os150nb)$ ncdump -h in2022_v06_os150nb.nc  
netcdf in2022_v06_os150nb {  
dimensions:  
    time = 1736 ;  
    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 = 201.130138888889 ;  
        time:data_max = 207.868587962963 ;  
    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 = 153.3075 ;  
        lon:data_max = 154.785416666667 ;  
    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 = -28.6294666666667 ;  
        lat:data_max = -26.6760972222222 ;  
    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 = 489.99f ;  
    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 = -1.104289f ;  
        u:data_max = 1.075975f ;  
    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 = -1.060211f ;  
        v:data_max = 0.329674f ;  
    short amp(time, depth_cell) ;  
        amp:missing_value = 32767s ;  
        amp:long_name = "Received signal strength" ;  
        amp:C_format = "%d" ;  
        amp:data_min = 23s ;  
        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 = -179.5196f ;
    heading:data_max = 179.3779f ;
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 = 20.26076f ;
    tr_temp:data_max = 22.5006f ;
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 = 66s ;
    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 = -5.686167f ;
    uship:data_max = 4.683662f ;
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 = -4.601994f ;
    vship:data_max = 5.63483f ;

// global attributes:
:featureType = "trajectoryProfile" ;
:history = "Created: 2022-10-26 00:04:57 UTC" ;
:Conventions = "COARDS" ;
:software = "pycurrents" ;
:hg_changeset = "3211:63370479787a" ;
:title = "Shipboard ADCP velocity profiles" ;
:description = "Shipboard ADCP velocity profiles from in2022_v06 using instrument os150nb -
Short Version." ;
:cruise_id = "in2022_v06" ;
: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",
    "=====\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",
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"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_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\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",  
"" ;
```

}