



## RV *Investigator* ADCP Data Processing Report

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<b>Voyage ID</b>	<b>IN2024_V01</b>
<b>Voyage Title</b>	Multidisciplinary Investigations of the Southern Ocean (MISO): Linking physics, biogeochemistry, plankton, aerosols, clouds and climate
<b>Depart</b>	Hobart, Tuesday 2 <sup>nd</sup> January 2024 0800 (AEST)
<b>Return</b>	Freemantle, Tuesday 5 <sup>th</sup> March 2024 1200 (AEST)
<b>Chief Scientist</b>	Dr Steve Rintoul (CSIRO)
<b>Data Processor</b>	Vito Dirita (CSIRO – E&T Data Acquisition & Processing)

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# Document History

Date	Version	Author	Comments
24 April 2024	1.0	Vito Dirita	Initial version

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# 1 Summary

The objective of this voyage was to improve the understanding of how the Southern Ocean region influences the Earth system and use this knowledge to improve models. This voyage characterised the properties of aerosols, clouds, radiation, and precipitation over the Southern Ocean south of Australia and investigate how they are shaped by interactions between the ocean, atmosphere, and biosphere. Repeat observations were used to discover how and why the region is changing and the consequences of Southern Ocean change for climate, biogeochemical cycles, biological productivity, and the future of the Antarctic Ice Sheet. The voyage sought new insights into the processes controlling the availability of iron and other trace elements and their role in regulating productivity in the Southern Ocean and the production of marine organic aerosols that can drive cloud nucleation. The observations and insights gained from the voyage will be used to develop, test, and implement new parameterisations for models used for weather forecasts and climate projections.

This report describes the production of quality-controlled ADCP data from RV *Investigator* voyage IN2024\_V01.

## Overall Data Quality:

Voyage was split into two as the drop keel location was moved without acquisition being stopped. WH75 was used for most of the voyage after OS75 stopped working on the 6<sup>th</sup> January. On the 23<sup>rd</sup> of February the WH75 failed, possibly due to water ingress into the cable.

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 in (Hummon, 2009-2021).

The RDI Ocean Surveyor OS150 and OS75 were run in narrowband mode (nb) and the RDI Ocean Surveyor WH75kHz ADCP was run in broadband mode (bb).

Internal triggering was used.

Both port and starboard drop keels are located approximately 6m below the water line, additionally both port and starboard keels were extended to:

- 0.0m from the start of the voyage until 4<sup>th</sup> January 23:40 (part-1 of the voyage)
- 1.2m thereafter until the end of the voyage (part-2 of the voyage)

Resulting in 6.0m and 7.2m below the water line respectively.

To access the full voyage plan and other reports and data associated with this voyage, please see the contact information at the end of this report.

## 1.1 Voyage Track

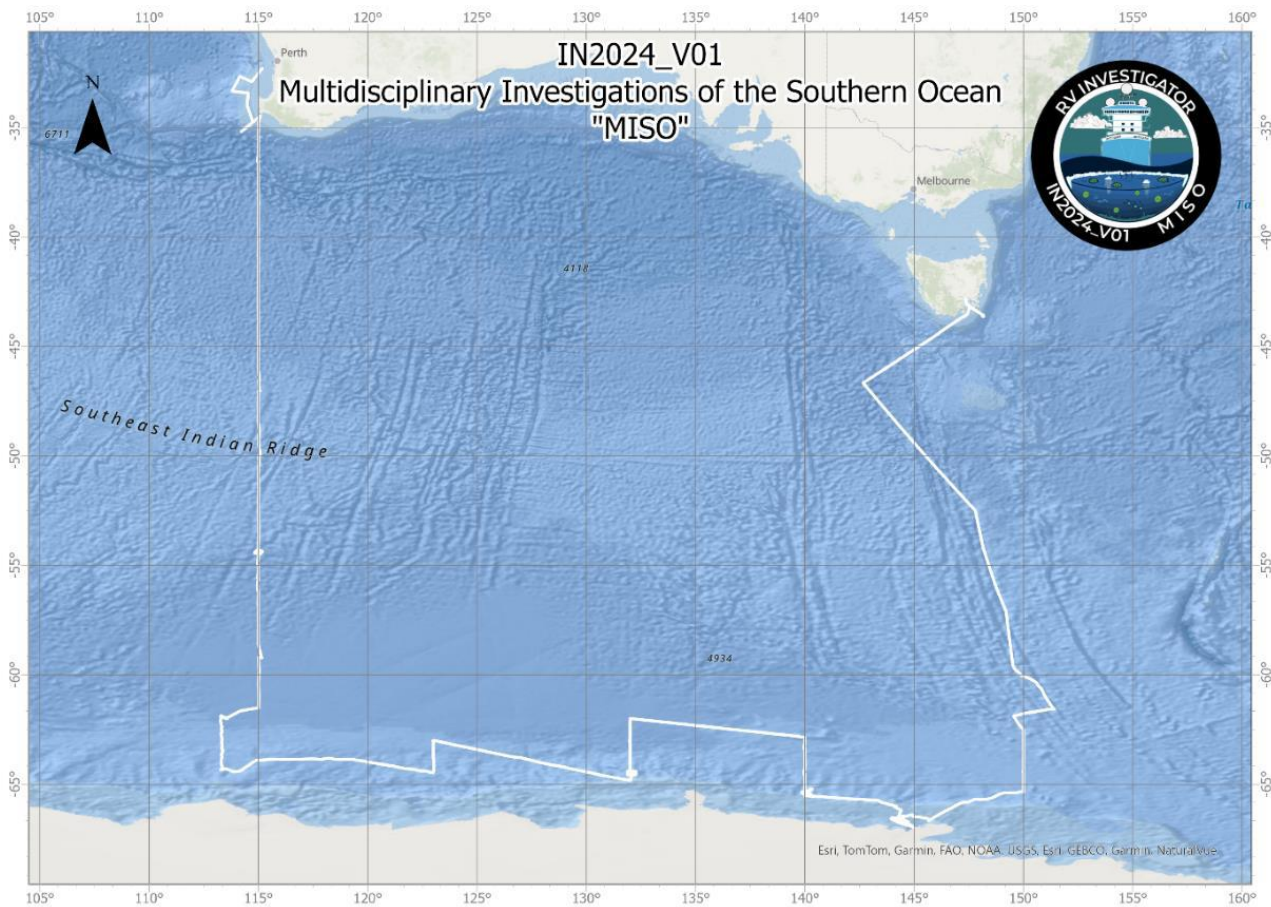


Figure 1: Voyage track

Please see the webpy folders for plots of collected data.

## 2 Data Processing

### 2.1 Background Information

The University of Hawaii's CODAS software (Built 2021-10-20) contained in their "focal\_20.04" Oracle VM Virtual Machine (VirtualBox) image was used for data post-processing.

### 2.2 Processing Notes

Only minor editing was required, data were masked where instrument anomalies were suspected and where the WH75, OS75 and OS150 data differed significantly. A heading correction was applied to both ADCPs using **patch\_hcorr.py** using bottom track calibration on both the OS75, OS150 and water tracking for the WH75bb.

## Dataset segmentation:

The processed dataset has been segmented into two parts, note that dx and dy refer to the transducer x and y offsets. Bottom tracking was used for the OS75 and OS150, water tracking for the WH75 in both Part-1 and 2 of the voyage.

### Voyage Part-1:

TRANSDUCER	Data Range	Offset: dX	Offset: dY
OS75	2 January 2024 to 5 January 2024	1	13
OS150	2 January 2024 to 5 January 2024	1	8
WH75	No data	n/a	n/a

### Voyage Part-2:

TRANSDUCER	Data Range	Offset: dX	Offset: dY
OS75	5 January 2024 to 4 March 2024	1	13
OS150	5 January 2024 to 4 March 2024	1	8
WH75	5 January 2024 to 23 February 2024	1	10

Table 1: Voyage ADCP Data Segmentation

## Amplitude and phase corrections:

TRANSDUCER	Voyage Part-1		Voyage Part-2	
	Amplitude	Phase	Amplitude	Phase
OS75	0.9979	-0.0568	0.9994	0.0454
OS150	1.0048	0.0048	1.0054	0.0599
WH75	n/a	n/a	1.0090	0.0230

Table 2: Amplitude and phase rotation corrections applied

## Final amplitude and phase rotations:

TRANSDUCER	Voyage Part-1		Voyage Part-2	
	Amplitude	Phase	Amplitude	Phase
OS75	1.0001	-0.0166	1.0000	0.0040
OS150	1.0003	-0.0088	1.0000	0.0000
WH75	n/a	n/a	1.0000	-0.0070

Table 3: Final OS75 and OS150 amplitude and phase

## Instrument Serial Numbers

Manufacturer	Instrument	Serial Number
TRDI	ADCP WH75 kHz	24473
TRDI	ADCP 75kHz	65008
TRDI	ADCP 150 kHz	61315

Table 1: ADCP serial numbers

## 3 NetCDF Data Headers

### PART-1: OS75nb

```
codaspy:(os75nb)$ ncdump -h in2024_v01_os75nb.nc
netcdf in2024_v01_os75nb {
dimensions:
    time = 855 ;
    depth_cell = 55 ;
variables:
    int trajectory ;
        trajectory:standard_name = "trajectory_id" ;
    double time(time) ;
        time:long_name = "Decimal day" ;
        time:units = "days since 2024-01-01 00:00:00" ;
        time:C_format = "%12.5f" ;
        time:standard_name = "time" ;
        time:data_min = 1.1218287037037 ;
        time:data_max = 4.08711805555556 ;
    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 = 147.330525 ;
        lon:data_max = 148.182105555556 ;
    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 = -43.6511444444444 ;
        lat:data_max = -42.8422861111111 ;
    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 = 29.97f ;
        depth:data_max = 893.99f ;
    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 = -1.18024f ;
        u:data_max = 1.061423f ;
    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 = "%.2f" ;
    v:data_min = -1.9578f ;
    v:data_max = 0.7347803f ;
short amp(time, depth_cell) ;
    amp:missing_value = 32767s ;
    amp:long_name = "Received signal strength" ;
    amp:C_format = "%d" ;
    amp:data_min = 7s ;
    amp:data_max = 200s ;
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 = "%.1f" ;
    heading:data_min = -179.7563f ;
    heading:data_max = 179.9606f ;
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 = "%.1f" ;
    tr_temp:data_min = 17.57359f ;
    tr_temp:data_max = 21.05789f ;
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 = 64s ;
    num_pings:data_max = 144s ;
float uship(time) ;
    uship:missing_value = 1.e+38f ;
    uship:long_name = "Ship zonal velocity component" ;
    uship:units = "meter second-1" ;
    uship:C_format = "%.4f" ;
    uship:data_min = -3.356627f ;
    uship:data_max = 5.238922f ;
float vship(time) ;
    vship:missing_value = 1.e+38f ;
    vship:long_name = "Ship meridional velocity component" ;
    vship:units = "meter second-1" ;
    vship:C_format = "%.4f" ;
    vship:data_min = -6.442744f ;
    vship:data_max = 4.261891f ;

// global attributes:
:featureType = "trajectoryProfile" ;
:history = "Created: 2024-04-23 02:03:45 UTC" ;
:Conventions = "COARDS" ;
:software = "pycurrents" ;
:hg_changeset = "3211:63370479787a" ;
:title = "Shipboard ADCP velocity profiles" ;
:description = "Shipboard ADCP velocity profiles from in2024_v01 using instrument os75nb - Short
Version." ;
:cruise_id = "in2024_v01" ;
:sonar = "os75nb" ;
:yearbase = 2024 ;
: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_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\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",
"" ;
}

```

## PART-1: OS150nb

```

codaspy:(os150nb)$ ncdump -h in2024_v01_os150nb.nc
netcdf in2024_v01_os150nb {
dimensions:
    time = 855 ;
    depth_cell = 60 ;
variables:
    int trajectory ;
        trajectory:standard_name = "trajectory_id" ;
    double time(time) ;
        time:long_name = "Decimal day" ;
        time:units = "days since 2024-01-01 00:00:00" ;

```

```

time:C_format = "%12.5f" ;
time:standard_name = "time" ;
time:data_min = 1.12180555555556 ;
time:data_max = 4.08710648148148 ;
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 = 147.330516666667 ;
lon:data_max = 148.182094444444 ;
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 = -43.6511888888889 ;
lat:data_max = -42.8422916666667 ;
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 = 17.95f ;
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 = -0.3882606f ;
u:data_max = 0.237494f ;
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 = -1.184463f ;
v:data_max = 0.1869231f ;
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 = -179.6948f ;
heading:data_max = 179.9582f ;
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 = 17.59624f ;
tr_temp:data_max = 20.92213f ;
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 = 118s ;
        num_pings:data_max = 252s ;
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 = -3.343261f ;
    uship:data_max = 5.197657f ;
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 = -6.388136f ;
    vship:data_max = 4.200441f ;

// global attributes:
:featureType = "trajectoryProfile" ;
:history = "Created: 2024-04-23 02:00:31 UTC" ;
:Conventions = "COARDS" ;
:software = "pycurrents" ;
:hg_changeset = "3211:63370479787a" ;
:title = "Shipboard ADCP velocity profiles" ;
:description = "Shipboard ADCP velocity profiles from in2024_v01 using instrument os150nb - Short
Version." ;

:cruise_id = "in2024_v01" ;
:sonar = "os150nb" ;
:yearbase = 2024 ;
: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

```

"time-varying heading correction. Additional algorithms developed more recently include translation of the GPS positions to the transducer location, and averaging of ship's speed over the times of valid pings when Percent Good is reduced. Such post-processing is needed prior to submission of \"processed ADCP data\" to JASADCP or other archives.

Full CODAS processing

-----

Whenever single-ping data have been recorded, full CODAS processing provides the best end product.

Full CODAS processing starts with the single-ping velocities in beam coordinates. Based on the transducer orientation relative to the hull, the beam velocities are transformed to horizontal, vertical, and \"error velocity\" components. Using a reliable heading (typically from the ship's gyro compass), the velocities in ship coordinates are rotated into earth coordinates.

Pings are grouped into an \"ensemble\" (usually 2-5 minutes duration) and undergo a suite of automated editing algorithms (removal of acoustic interference; identification of the bottom; editing based on thresholds; and specialized editing that targets CTD wire interference and \"weak, biased profiles\". The ensemble of single-ping velocities is then averaged using an iterative reference layer averaging scheme. Each ensemble is approximated as a single function of depth, with a zero-average over a reference layer plus a reference layer velocity for each ping. Adding the average of the single-ping reference layer velocities to the function of depth yields the ensemble-average velocity profile. These averaged profiles, along with ancillary measurements, are written to disk, and subsequently loaded into the CODAS database. Everything after this stage is \"post-processing\".

note (time):

-----

Time is stored in the database using UTC Year, Month, Day, Hour, Minute, Seconds. Floating point time \"Decimal Day\" is the floating point interval in days since the start of the year, usually the year of the first day of the cruise.

note (heading):

-----

CODAS processing uses heading from a reliable device, and (if available) uses a time-dependent correction by an accurate heading device. The reliable heading device is typically a gyro compass (for example, the Bridge gyro). Accurate heading devices can be POSMV, Seapath, Phins, Hydrins, MAHRS, or various Ashtech devices; this varies with the technology of the time. It is always confusing to keep track of the sign of the heading correction. Headings are written degrees, positive clockwise. setting up some variables:

X = transducer angle (CONFIG1\_heading\_bias) positive clockwise (beam 3 angle relative to ship)

G = Reliable heading (gyrocompass)

A = Accurate heading

dh = G - A = time-dependent heading correction (ANCIL2\_watrk\_hd\_misalign)

Rotation of the measured velocities into the correct coordinate system amounts to  $(u+iv) \cdot (\exp(i\theta))$  where theta is the sum of the corrected heading and the transducer angle.

$\theta = X + (G - dh) = X + G - dh$

Watertrack and Bottomtrack calibrations give an indication of the residual angle offset to apply, for example if mean and median of the phase are all 0.5 (then R=0.5). Using the \"rotate\" command, the value of R is added to \"ANCIL2\_watrk\_hd\_misalign\".

new\_dh = dh + R

Therefore the total angle used in rotation is

new\_theta = X + G - dh\_new  
= X + G - (dh + R)  
= (X - R) + (G - dh)

```

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

```

## PART-2: OS150nb

```

codaspy:(os150nb)$ ncdump -h in2024_v01_os150nb.nc
netcdf in2024_v01_os150nb {
dimensions:
    time = 17010 ;
    depth_cell = 60 ;
variables:
    int trajectory ;
        trajectory:standard_name = "trajectory_id" ;
    double time(time) ;
        time:long_name = "Decimal day" ;
        time:units = "days since 2024-01-01 00:00:00" ;
        time:C_format = "%12.5f" ;
        time:standard_name = "time" ;
        time:data_min = 4.15688657407407 ;
        time:data_max = 63.8113078703704 ;
    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 = 113.246183333333 ;
        lon:data_max = 151.416694444444 ;
    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 = -67.0026222222222 ;
        lat:data_max = -31.9326777777778 ;
    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 = -0.9091744f ;
        u:data_max = 0.9664981f ;
    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 = -1.198396f ;
v:data_max = 0.8174655f ;
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 = 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 = -179.999f ;
heading:data_max = 179.9937f ;
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 = -1.379677f ;
tr_temp:data_max = 23.10351f ;
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 = 17s ;
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 = -6.485657f ;
uship:data_max = 4.835031f ;
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 = -7.071651f ;
vship:data_max = 6.611674f ;

// global attributes:
:featureType = "trajectoryProfile" ;
:history = "Created: 2024-04-24 00:30:55 UTC" ;
:Conventions = "COARDS" ;
:software = "pycurrents" ;
:hg_changeset = "3211:63370479787a" ;
:title = "Shipboard ADCP velocity profiles" ;
:description = "Shipboard ADCP velocity profiles from in2024_v01 using instrument os150nb - Short
Version." ;
:cruise_id = "in2024_v01" ;
:sonar = "os150nb" ;
:yearbase = 2024 ;
: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",
"\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_watrck_hd_misalign)\n",
"\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",
"\n",
"theta = X + (G - dh) = X + G - dh\n",
"\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_watrck_hd_misalign\".\n",
"\n",
"new_dh = dh + R\n",
"\n",
"Therefore the total angle used in rotation is\n",
"\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_watrck_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\n",
"110         6                bad\n",
"111         7                bad\n",
"-----+-----+-----+-----+\n",
"" ;
}

```

## PART-2: OS75nb

```

codaspy:(os75nb)$ ncdump -h in2024_v01_os75nb.nc
netcdf in2024_v01_os75nb {
dimensions:
    time = 2393 ;
    depth_cell = 55 ;
variables:
    int trajectory ;
        trajectory:standard_name = "trajectory_id" ;
    double time(time) ;
        time:long_name = "Decimal day" ;
        time:units = "days since 2024-01-01 00:00:00" ;
        time:C_format = "%12.5f" ;
        time:standard_name = "time" ;

```

```

        time:data_min = 4.59270833333333 ;
        time:data_max = 63.8113425925926 ;
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 = 113.791225 ;
    lon:data_max = 145.625191666667 ;
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 = -44.7852777777778 ;
    lat:data_max = -31.9326666666667 ;
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 = 29.93f ;
    depth:data_max = 893.99f ;
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 = -0.9021108f ;
    u:data_max = 0.6552185f ;
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 = -0.8318914f ;
    v:data_max = 0.6449676f ;
short amp(time, depth_cell) ;
    amp:missing_value = 32767s ;
    amp:long_name = "Received signal strength" ;
    amp:C_format = "%d" ;
    amp:data_min = 7s ;
    amp:data_max = 181s ;
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 = -177.4187f ;
    heading:data_max = 179.3657f ;
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 = 16.27567f ;
    tr_temp:data_max = 23.35708f ;
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 = 64s ;
    num_pings:data_max = 144s ;

```

```

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 = -4.883102f ;
    uship:data_max = 4.500887f ;
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 = -3.150547f ;
    vship:data_max = 6.617968f ;

// global attributes:
:featureType = "trajectoryProfile" ;
:history = "Created: 2024-04-24 00:32:55 UTC" ;
:Conventions = "COARDS" ;
:software = "pycurrents" ;
:hg_changeset = "3211:63370479787a" ;
:title = "Shipboard ADCP velocity profiles" ;
:description = "Shipboard ADCP velocity profiles from in2024_v01 using instrument os75nb - Short
Version." ;

:cruise_id = "in2024_v01" ;
:sonar = "os75nb" ;
:yearbase = 2024 ;
: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

```

"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\n",
"100      4                bad\n",
"101      5                bad\n",
"110      6                bad\n",
"111      7                bad\n",
"-----+-----+-----+-----+\n",
"" ;
}

```

## PART-2: WH75bb

```

codaspy:(wh75)$ ncdump -h in2024_v01_wh75bb.nc
netcdf in2024_v01_wh75bb {
dimensions:
    time = 13341 ;
    depth_cell = 100 ;
variables:
    int trajectory ;
        trajectory:standard_name = "trajectory_id" ;
    double time(time) ;
        time:long_name = "Decimal day" ;
        time:units = "days since 2024-01-01 00:00:00" ;
        time:C_format = "%12.5f" ;
        time:standard_name = "time" ;
        time:data_min = 4.66231481481482 ;
        time:data_max = 53.3637731481481 ;
    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 = 113.249375 ;
        lon:data_max = 151.413280555556 ;
    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 = -67.0026527777778 ;
        lat:data_max = -43.5437722222222 ;
    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 = 22.13f ;
        depth:data_max = 814.34f ;
    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 = -0.7341025f ;
        u:data_max = 1.107811f ;
    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 = -1.188275f ;
        v:data_max = 1.145403f ;
}

```

```

short amp(time, depth_cell) ;
    amp:missing_value = 32767s ;
    amp:long_name = "Received signal strength" ;
    amp:C_format = "%d" ;
    amp:data_min = 32s ;
    amp:data_max = 206s ;
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 = -179.998f ;
    heading:data_max = 179.9972f ;
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 = -1.714091f ;
    tr_temp:data_max = 17.61246f ;
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 = 12s ;
    num_pings:data_max = 180s ;
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 = -6.496566f ;
    uship:data_max = 4.82088f ;
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 = -7.051157f ;
    vship:data_max = 6.418228f ;

// global attributes:
:featureType = "trajectoryProfile" ;
:history = "Created: 2024-04-24 00:36:47 UTC" ;
:Conventions = "COARDS" ;
:software = "pycurrents" ;
:hg_changeset = "3211:63370479787a" ;
:title = "Shipboard ADCP velocity profiles" ;
:description = "Shipboard ADCP velocity profiles from in2024_v01 using instrument wh75bb - Short
Version." ;
:cruise_id = "in2024_v01" ;
:sonar = "wh75bb" ;
:yearbase = 2024 ;
: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",
"-----

```

```

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

```

## 4 References

Alix Post (2023). The RV Investigator. *Voyage Plan IN2024\_V01*. Retrieved from Marine National Facility: Voyage Plans and summaries:

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