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RV *Investigator* ADCP Data Processing Report

Voyage ID	**IN2023_V07**
Voyage Title	SWOT_ACC - Smaller Scales of the Antarctic Circumpolar Current in a Meander South of Tasmania
Depart	Hobart, 0930 Monday, 15th November 2023 (AEST)
Return	Hobart, 0815 Wednesday, 20th December 2023 (AEST)
Chief Scientist	Dr. Benoit Legresy (CSIRO)
Data Processor	Vito Dirita (CSIRO – E&T Data Acquisition & Processing)

Document History

Date	Version	Author	Comments
29 February 2024	1.0	Vito Dirita	Initial version

Contents

1 Summary

The primary focus of this voyage was to enhance our ability to observe and comprehend the effects of small-scale motions (ranging from 10 to 100 km) on the dynamics of the Antarctic Circumpolar Current (ACC). The groundbreaking Surface Water Ocean Topography (SWOT) satellite mission will provide unprecedented measurements of sea surface height over a wide area with substantially improved spatial resolution compared to traditional altimeters. While SWOT will offer unparalleled coverage in both space and time, it is crucial to obtain in situ subsurface ocean measurements to validate the satellite observations and establish the connection between small-scale variability in sea surface height and subsurface ocean circulation and dynamics.

This report describes the production of quality-controlled ADCP data from RV *Investigator* voyage IN2023_V07.

Overall Data Quality:

The OS75 was not turned on due to the degraded performance, the WH75 was installed on the starboard drop keel to make up for the faulty OS75 and worked well for the duration of the voyage. The OS150 operated normally.

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 OS150kHz was 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 by 1.2m for the entire duration of the voyage, subsequently the transducers were located approximately 7.2m below the water line.

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

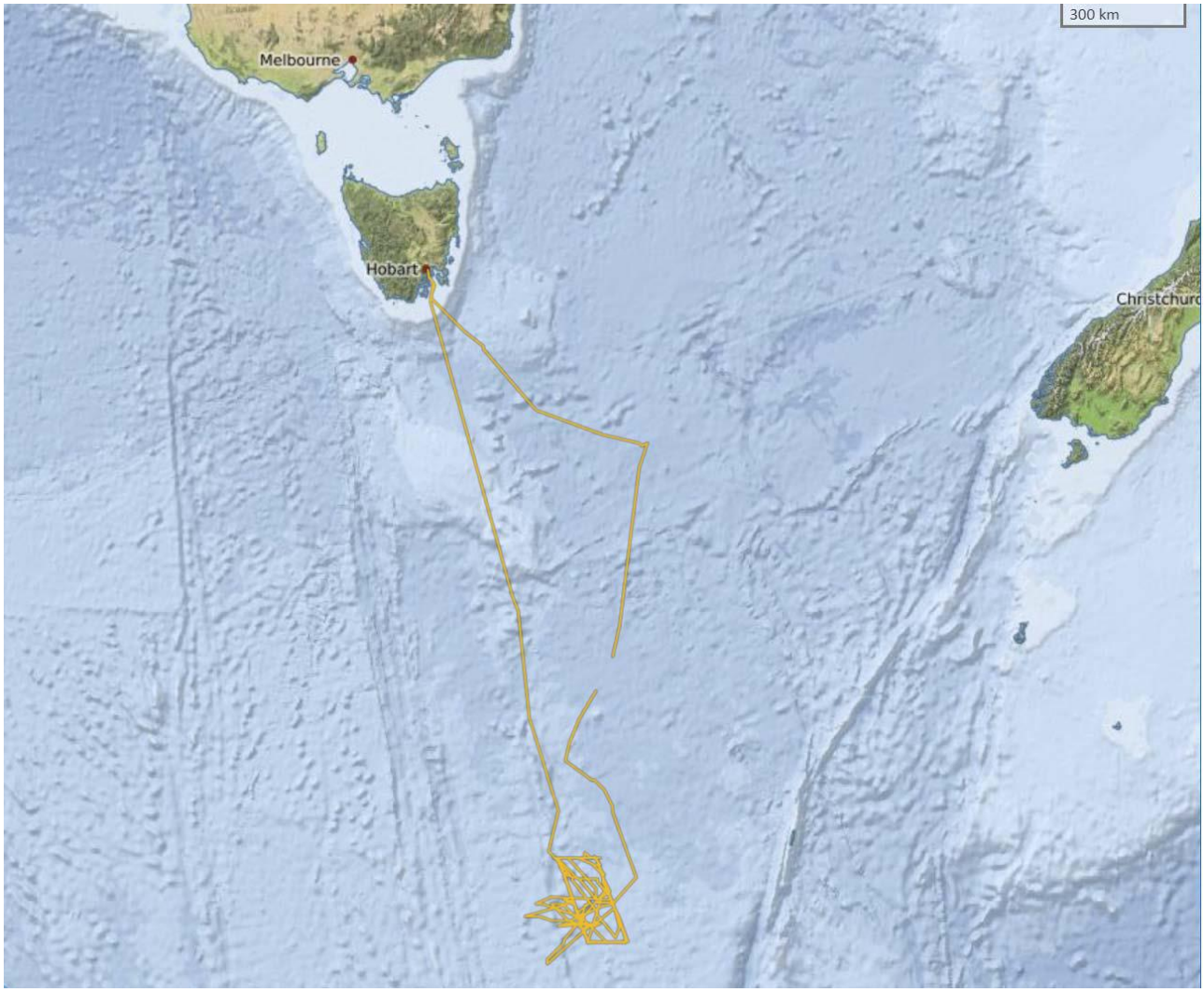

Figure 1: Voyage track

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 and OS150 data differed significantly. A heading correction was applied to both ADCPs using **patch_hcorr.py** using bottom track calibration on both WH75bb and OS150nb.

Dataset segmentation:

The processed dataset has been segmented into 3 temporal parts, due to ADCP testing that required starting a new voyage in the UHDAS acquisition software.

Note that dx and dy refer to the transducer x and y offsets and which was kindly provided by J.Hummon (University of Hawaii Data Acquisition System UHDAS).

Voyage Segment	WH75			OS150		
	dx	dy	Data Range	dx	dy	Data Range
1	4	16	No data	-1	3	2023/11/14 - 2023/11/16
2	4	16	2023/11/16 - 2023/12/18	-1	3	2023/11/16 - 2023/12/18
3	4	16	2023/12/18 - 2023/12/19	-1	3	2023/12/18 - 2023/12/19

Table 1: Voyage ADCP Data Segmentation

Amplitude and phase corrections:

Voyage Segment	WH75		OS150	
Dates	Amplitude	Phase	Amplitude	Phase
2023/11/14 - 2023/11/16	-	-	1.0057	-0.0563
2023/11/16 - 2023/12/18	1.0085	-0.1530	1.0080	0.0030
2023/12/18 - 2023/12/19	-	-	1.0091	-0.0868

Table 2: Amplitude and phase rotation corrections applied

Final amplitude and phase rotations:

Voyage Segment	WH75		OS150	
Dates	Amplitude	Phase	Amplitude	Phase
2023/11/14 - 2023/11/16	-	-	1.0000	0.0005
2023/11/16 - 2023/12/18	0.9995	0.0055	1.0000	-0.0040
2023/12/18 - 2023/12/19	-	-	1.0000	0.0011

Table 3: Final OS75 and OS150 amplitude and phase

Instrument Serial Numbers

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

Table 1: ADCP serial numbers

3 NetCDF Data Headers

os150nb – part-1:

```
codaspy:(os150nb)$ ncdump -h in2023_v07_os150nb.nc
netcdf in2023_v07_os150nb {
dimensions:
        time = 374 ;
        depth_cell = 60 ;
variables:
        int trajectory ;
                trajectory:standard_name = "trajectory_id" ;
        double time(time) ;
                time:long_name = "Decimal day" ;
                time:units = "days since 2023-01-01 00:00:00" ;
                time:C_format = "%12.5f" ;
                time:standard_name = "time" ;
                time:data_min = 317.982002314815 ;
                time:data_max = 319.283865740741 ;
        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 = 147.374769444444 ;
                lon:data_max = 152.624866666667 ;
        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 = -46.4832916666667 ;
                lat:data_max = -42.9698194444444 ;
        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 = 17.98f ;
                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 = -0.5966563f ;
                u:data_max = 0.6332595f ;
        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 = -0.4158566f ;
                v:data_max = 0.4483795f ;
        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 = -176.1102f ;
                heading:data_max = 175.5161f ;
        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 = 12.10024f ;
                tr_temp:data_max = 15.97206f ;
        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 = 68s ;
                num_pings:data_max = 250s ;
        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 = -2.63245f ;
                uship:data_max = 5.603516f ;
        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 = -5.625684f ;
                vship:data_max = -1.490041f ;

// global attributes:
                :featureType = "trajectoryProfile" ;
                :history = "Created: 2024-02-28 22:57:15 UTC" ;
                :Conventions = "COARDS" ;
                :software = "pycurrents" ;
                :hg_changeset = "3211:63370479787a" ;
                :title = "Shipboard ADCP velocity profiles" ;
                :description = "Shipboard ADCP velocity profiles from in2023_v07 using instrument os150nb - Short
Version." ;
                :cruise_id = "in2023_v07" ;
                :sonar = "os150nb" ;
                :yearbase = 2023 ;
                :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                            bad\n",
                        "010         2                  bad\n",
                        "011         3                  bad       bad\n",
                        "100         4         bad\n",
                        "101         5         bad                bad\n",
                        "110         6         bad      bad\n",
                        "111         7         bad      bad       bad\n",
                        "-------+----------+--------+----------+-------+\n",
                        "" ;
}
```

wh75bb – part-2:

```
codaspy:(wh75)$ ncdump -h in2023_v07_wh75bb.nc
netcdf in2023_v07_wh75bb {
dimensions:
        time = 9121 ;
        depth_cell = 100 ;
variables:
        int trajectory ;
                trajectory:standard_name = "trajectory_id" ;
        double time(time) ;
                time:long_name = "Decimal day" ;
                time:units = "days since 2023-01-01 00:00:00" ;
```

```
        time:C_format = "%12.5f" ;
        time:standard_name = "time" ;
        time:data_min = 319.288240740741 ;
        time:data_max = 351.168877314815 ;
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 = 149.744955555556 ;
        lon:data_max = 154.291858333333 ;
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 = -56.8620638888889 ;
        lat:data_max = -46.4902027777778 ;
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 = 22.17f ;
        depth:data_max = 814.28f ;
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 = -0.7998395f ;
        u:data_max = 1.063463f ;
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 = -0.9410405f ;
        v:data_max = 0.944032f ;
short amp(time, depth_cell) ;
        amp:missing_value = 32767s ;
        amp:long_name = "Received signal strength" ;
        amp:C_format = "%d" ;
        amp:data_min = 33s ;
        amp:data_max = 205s ;
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 = -179.9675f ;
        heading:data_max = 179.9507f ;
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 = 1.596836f ;
        tr_temp:data_max = 11.38667f ;
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 = 179s ;
        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 = -5.273402f ;
                uship:data_max = 6.168085f ;
        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 = -5.804386f ;
                vship:data_max = 5.893715f ;

// global attributes:
                :featureType = "trajectoryProfile" ;
                :history = "Created: 2024-02-28 23:08:28 UTC" ;
                :Conventions = "COARDS" ;
                :software = "pycurrents" ;
                :hg_changeset = "3211:63370479787a" ;
                :title = "Shipboard ADCP velocity profiles" ;
                :description = "Shipboard ADCP velocity profiles from in2023_v07 using instrument wh75bb - Short
Version." ;
                :cruise_id = "in2023_v07" ;
                :sonar = "wh75bb" ;
                :yearbase = 2023 ;
                :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                            bad\n",
                    "010         2                 bad\n",
                    "011         3                 bad        bad\n",
                    "100         4         bad\n",
                    "101         5         bad                bad\n",
                    "110         6         bad      bad\n",
                    "111         7         bad      bad       bad\n",
                    "-------+----------+--------+----------+-------+\n",
                    "" ;
}
```

---

os150nb – part-2:

```
codaspy:(os150nb)$ ncdump -h in2023_v07_os150nb.nc
netcdf in2023_v07_os150nb {
dimensions:
        time = 9166 ;
        depth_cell = 60 ;
variables:
        int trajectory ;
                trajectory:standard_name = "trajectory_id" ;
        double time(time) ;
                time:long_name = "Decimal day" ;
                time:units = "days since 2023-01-01 00:00:00" ;
                time:C_format = "%12.5f" ;
                time:standard_name = "time" ;
                time:data_min = 319.292476851852 ;
                time:data_max = 351.167962962963 ;
        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 = 149.7465 ;
                lon:data_max = 154.291880555556 ;
        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 = -56.8621527777778 ;
                lat:data_max = -46.4965944444444 ;
        float depth(time, depth_cell) ;
                depth:missing_value = 1.e+38f ;
                depth:long_name = "Depth" ;
                depth:units = "meter" ;
                depth:C_format = "%8.2f" ;
                depth:positive = "down" ;
                depth:data_min = 17.93f ;
                depth:data_max = 490.f ;
        float u(time, depth_cell) ;
                u:missing_value = 1.e+38f ;
                u:long_name = "Zonal velocity component" ;
                u:units = "meter second-1" ;
                u:C_format = "%7.2f" ;
                u:data_min = -0.7951373f ;
                u:data_max = 1.019193f ;
        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 = -0.9969611f ;
                v:data_max = 1.003667f ;
        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 = 2b ;
        float heading(time) ;
                heading:missing_value = 1.e+38f ;
                heading:long_name = "Ship heading" ;
                heading:units = "degrees" ;
                heading:C_format = "%6.1f" ;
                heading:data_min = -179.9654f ;
                heading:data_max = 179.934f ;
        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 = 1.931124f ;
                tr_temp:data_max = 12.19885f ;
        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 = 145s ;
                num_pings:data_max = 250s ;
        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 = -5.276755f ;
                uship:data_max = 6.166131f ;
        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 = -5.80723f ;
                vship:data_max = 5.884319f ;

// global attributes:
                :featureType = "trajectoryProfile" ;
                :history = "Created: 2024-02-28 23:06:12 UTC" ;
                :Conventions = "COARDS" ;
                :software = "pycurrents" ;
                :hg_changeset = "3211:63370479787a" ;
                :title = "Shipboard ADCP velocity profiles" ;
                :description = "Shipboard ADCP velocity profiles from in2023_v07 using instrument os150nb - Short
Version." ;
                :cruise_id = "in2023_v07" ;
                :sonar = "os150nb" ;
                :yearbase = 2023 ;
                :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                           bad\n",
                        "010         2                  bad\n",
                        "011         3                  bad       bad\n",
                        "100         4          bad\n",
                        "101         5          bad             bad\n",
                        "110         6          bad       bad\n",
                        "111         7          bad       bad       bad\n",
                        "-------+----------+--------+----------+-------+\n",
                        "" ;
}
```

---

wh75bb – part-3:

```
codaspy:(wh75)$ ncdump -h in2023_v07_wh75bb.nc
netcdf in2023_v07_wh75bb {
dimensions:
        time = 432 ;
        depth_cell = 100 ;
variables:
        int trajectory ;
                trajectory:standard_name = "trajectory_id" ;
        double time(time) ;
                time:long_name = "Decimal day" ;
                time:units = "days since 2023-01-01 00:00:00" ;
                time:C_format = "%12.5f" ;
```

```
        time:standard_name = "time" ;
        time:data_min = 351.220671296296 ;
        time:data_max = 352.809444444444 ;
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 = 147.376972222222 ;
        lon:data_max = 149.656908333333 ;
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 = -49.0563194444444 ;
        lat:data_max = -42.9868 ;
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 = 22.26f ;
        depth:data_max = 814.35f ;
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 = -0.5297228f ;
        u:data_max = 0.5937998f ;
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 = -0.7360177f ;
        v:data_max = 0.890337f ;
short amp(time, depth_cell) ;
        amp:missing_value = 32767s ;
        amp:long_name = "Received signal strength" ;
        amp:C_format = "%d" ;
        amp:data_min = 38s ;
        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 = -63.72404f ;
        heading:data_max = 15.11956f ;
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 = 9.165423f ;
        tr_temp:data_max = 18.39403f ;
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 = 145s ;
```

```
                num_pings:data_max = 177s ;
        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 = -2.879431f ;
                uship:data_max = 0.8096123f ;
        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 = 1.548101f ;
                vship:data_max = 6.465752f ;

// global attributes:
                :featureType = "trajectoryProfile" ;
                :history = "Created: 2024-02-28 23:14:09 UTC" ;
                :Conventions = "COARDS" ;
                :software = "pycurrents" ;
                :hg_changeset = "3211:63370479787a" ;
                :title = "Shipboard ADCP velocity profiles" ;
                :description = "Shipboard ADCP velocity profiles from in2023_v07 using instrument wh75bb - Short
Version." ;
                :cruise_id = "in2023_v07" ;
                :sonar = "wh75bb" ;
                :yearbase = 2023 ;
                :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                            bad\n",
                    "010         2                 bad\n",
                    "011         3                 bad       bad\n",
                    "100         4         bad\n",
                    "101         5         bad               bad\n",
                    "110         6         bad      bad\n",
                    "111         7         bad      bad       bad\n",
                    "-------+----------+--------+----------+-------+\n",
                    "" ;
}
```

---

os150nb – part-3:

```
codaspy:(os150nb)$ pwd
/home/adcpproc/adcp_data/in2023_v07/in2023_v07_part3/proc/os150nb
codaspy:(os150nb)$ ncdump -h in2023_v07_os150nb.nc
netcdf in2023_v07_os150nb {
dimensions:
        time = 471 ;
        depth_cell = 60 ;
variables:
        int trajectory ;
                trajectory:standard_name = "trajectory_id" ;
        double time(time) ;
                time:long_name = "Decimal day" ;
                time:units = "days since 2023-01-01 00:00:00" ;
                time:C_format = "%12.5f" ;
                time:standard_name = "time" ;
                time:data_min = 351.174895833333 ;
                time:data_max = 352.806840277778 ;
        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 = 147.377844444444 ;
                lon:data_max = 149.734305555556 ;
        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 = -49.2380666666667 ;
                lat:data_max = -42.9918722222222 ;
        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 = 17.96f ;
                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 = -0.673618f ;
                u:data_max = 0.6466286f ;
        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 = -0.4738631f ;
                v:data_max = 0.7727909f ;
        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 = 229s ;
        byte pg(time, depth_cell) ;
                pg:missing_value = -1b ;
                pg:long_name = "Percent good pings" ;
                pg:C_format = "%d" ;
                pg:data_min = 0b ;
                pg:data_max = 100b ;
        byte pflag(time, depth_cell) ;
                pflag:long_name = "Editing flags" ;
                pflag:C_format = "%d" ;
                pflag:data_min = 0b ;
                pflag:data_max = 6b ;
        float heading(time) ;
                heading:missing_value = 1.e+38f ;
                heading:long_name = "Ship heading" ;
                heading:units = "degrees" ;
                heading:C_format = "%6.1f" ;
                heading:data_min = -64.36303f ;
                heading:data_max = 15.20907f ;
        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 = 9.100156f ;
                tr_temp:data_max = 18.44992f ;
        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 = 107s ;
                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 = -2.873983f ;
                uship:data_max = 0.8423095f ;
        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 = 1.525777f ;
                vship:data_max = 6.465319f ;

// global attributes:
                :featureType = "trajectoryProfile" ;
                :history = "Created: 2024-02-28 23:15:57 UTC" ;
                :Conventions = "COARDS" ;
                :software = "pycurrents" ;
                :hg_changeset = "3211:63370479787a" ;
                :title = "Shipboard ADCP velocity profiles" ;
                :description = "Shipboard ADCP velocity profiles from in2023_v07 using instrument os150nb - Short
Version." ;
                :cruise_id = "in2023_v07" ;
                :sonar = "os150nb" ;
                :yearbase = 2023 ;
                :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                             bad\n",
                    "010         2                  bad\n",
                    "011         3                  bad       bad\n",
                    "100         4          bad\n",
                    "101         5          bad               bad\n",
                    "110         6          bad       bad\n",
                    "111         7          bad       bad       bad\n",
                    "-------+----------+--------+----------+-------+\n",
                    "" ;
}
```

4 References

Benoit Legresy (2023). The RV Investigator. *Voyage Plan* IN2023_V07. Retrieved from Marine National Facility: Voyage Plans and summaries: https://www.cmar.csiro.au/data/reporting/get_file.cfm?eov_pub_id=3226

Hummon, J. (2009-2021). *CODAS+UHDAS Documentation*. Retrieved February 1, 2023, from https://currents.soest.hawaii.edu/docs/adcp_doc

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