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Australia's National Science Agency,
on behalf of the nation

RV *Investigator* ADCP Data Processing Report

Voyage ID	**IN2022_V09**
Voyage Title	Valuing Australia's new Gascoyne Marine Park
Depart	AMC CUF, Henderson, Fremantle, 19th Nov 2022, 00:00 UTC
Return	AMC CUF, Henderson, Fremantle, 19th Dec 2022, 07:00 UTC
Chief Scientist	John Keesing (CSIRO)
Data Processor	Anoosh Sarraf (CSIRO – E&T Data Acquisition & Processing)

Document History

Date	Version	Author	Comments
24 February 2023	1.0	Anoosh Sarraf	Initial version
1 March 2023	1.1	Anoosh Sarraf	Reviewed (HB)

Contents

1 Summary

The Gascoyne region of Australia's seafloor was identified for protection as an area of national significance and has been proclaimed as a marine park since 2013. The Gascoyne marine park lies in an area with great but poorly known biological diversity and potential for economic development. This voyage determined the diversity of fishes and of key habitat forming and mobile marine invertebrates across the range of depth regions in the marine park. The data collected during the survey provides descriptions of the physical and biological habitat types in the marine park and will form the basis for future monitoring and reviews of marine park performance and zoning.

This report describes the production of quality-controlled ADCP data from RV *Investigator* voyage IN2022_V09.

The ADCP was run for a notable part of the voyage, though it was turned off occasionally to avoid creating interference with the sounders and USBL.

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).

Both the RDI Ocean Surveyor 150kHz ADCP and the RDI Ocean Surveyor 75kHz ADCP were run in narrowband mode.

Internal triggering was used.

The drop keel was set at 1.19m below the waterline for the duration of the voyage.

Apart from the gap in the data, due to ADCP being turned on/off, and the usually required quality control data cleaning there were no significant ADCP processing-related issues encountered.

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" Virtual Machine image was used for data post-processing.

2.2 Processing Notes

Some editing was required, data were masked where instrument anomalies were suspected and where the OS75 and OS150 data differed significantly. A heading correction was applied to both ADCPs using **patch_hcorr.py** using bottom track calibration:

OS75		**OS150**	
Amplitude	**Phase**	**Amplitude**	**Phase**
0.9964	0.0552	1.0038	0.0538

Table 1: Amplitude and phase rotation corrections applied

OS75		OS150	
Amplitude	**Phase**	**Amplitude**	**Phase**
1.0001	0.0032	1.0001	0.0016

Table 2: Final OS75 and OS150 amplitude and phase

Bottom-track Amplitude and Phase rotation calibration were applied to the data. When processing the data, the true transducer offsets from the GPS position of the ship were as follows:

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

Table 3: True ADCP transducer offsets from GPS position

Instrument Serial Numbers

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

Table 4: ADCP serial numbers

3 NetCDF Data Headers

```
netcdf in2022_v09_os75nb {
dimensions:
        time = 4515 ;
        depth_cell = 60 ;
variables:
        int trajectory ;
                trajectory:standard_name = "trajectory_id" ;
        double time(time) ;
                time:long_name = "Decimal day" ;
                time:units = "days since 2022-01-01 00:00:00" ;
                time:C_format = "%12.5f" ;
                time:standard_name = "time" ;
                time:data_min = 322.224375 ;
                time:data_max = 352.133449074074 ;
```

```
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 = 110.339152777778 ;
        lon:data_max = 115.704141666667 ;
double lat(time) ;
        lat:missing_value = 1.e+38 ;
        lat:long_name = "Latitude" ;
        lat:units = "degrees_north" ;
        lat:C_format = "%9.4f" ;
        lat:standard_name = "latitude" ;
        lat:data_min = -32.1988666666667 ;
        lat:data_max = -20.7905194444444 ;
float depth(time, depth_cell) ;
        depth:missing_value = 1.e+38f ;
        depth:long_name = "Depth" ;
        depth:units = "meter" ;
        depth:C_format = "%8.2f" ;
        depth:positive = "down" ;
        depth:data_min = 29.99f ;
        depth:data_max = 973.99f ;
float u(time, depth_cell) ;
        u:missing_value = 1.e+38f ;
        u:long_name = "Zonal velocity component" ;
        u:units = "meter second-1" ;
        u:C_format = "%7.2f" ;
        u:data_min = -0.697988f ;
        u:data_max = 0.8890634f ;
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 = -1.249564f ;
        v:data_max = 0.6529822f ;
short amp(time, depth_cell) ;
        amp:missing_value = 32767s ;
        amp:long_name = "Received signal strength" ;
        amp:C_format = "%d" ;
        amp:data_min = 25s ;
        amp:data_max = 217s ;
byte pg(time, depth_cell) ;
        pg:missing_value = -1b ;
        pg:long_name = "Percent good pings" ;
        pg:C_format = "%d" ;
```

```
                pg:data_min = 0b ;
                pg:data_max = 100b ;
        byte pflag(time, depth_cell) ;
                pflag:long_name = "Editing flags" ;
                pflag:C_format = "%d" ;
                pflag:data_min = 0b ;
                pflag:data_max = 6b ;
        float heading(time) ;
                heading:missing_value = 1.e+38f ;
                heading:long_name = "Ship heading" ;
                heading:units = "degrees" ;
                heading:C_format = "%6.1f" ;
                heading:data_min = -179.9622f ;
                heading:data_max = 179.9805f ;
        float tr_temp(time) ;
                tr_temp:missing_value = 1.e+38f ;
                tr_temp:long_name = "ADCP transducer temperature" ;
                tr_temp:units = "Celsius" ;
                tr_temp:C_format = "%4.1f" ;
                tr_temp:data_min = 19.09378f ;
                tr_temp:data_max = 26.40015f ;
        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 = 14s ;
                num_pings:data_max = 133s ;
        float uship(time) ;
                uship:missing_value = 1.e+38f ;
                uship:long_name = "Ship zonal velocity component" ;
                uship:units = "meter second-1" ;
                uship:C_format = "%9.4f" ;
                uship:data_min = -6.656261f ;
                uship:data_max = 6.131636f ;
        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 = -6.429936f ;
                vship:data_max = 6.416821f ;

// global attributes:
                :featureType = "trajectoryProfile" ;
                :history = "Created: 2023-02-17 03:33:43 UTC" ;
                :Conventions = "COARDS" ;
                :software = "pycurrents" ;
                :hg_changeset = "3211:63370479787a" ;
```

```
		:title = "Shipboard ADCP velocity profiles" ;
		:description = "Shipboard ADCP velocity profiles from in2022_v09 using instrument
os75nb - Short Version." ;
		:cruise_id = "in2022_v09" ;
		:sonar = "os75nb" ;
		:yearbase = 2022 ;
		:ship_name = "RV Investigator" ;
		:CODAS_variables = "\n",
			"Variables in this CODAS short-form Netcdf file are intended for most end-
user\n",
			"scientific analysis and display purposes. For additional information see\n",
			"the CODAS_processing_note global attribute and the attributes of each\n",
			"of the variables.\n",
			"\n",
			"\n",
	"================================================================================\n",
			"time          Time at the end of the ensemble, days from start of year.\n",
			"lon, lat      Longitude, Latitude from GPS at the end of the ensemble.\n",
			"u,v           Ocean zonal and meridional velocity component profiles.\n",
			"uship, vship  Zonal and meridional velocity components of the ship.\n",
			"heading       Mean ship heading during the ensemble.\n",
			"depth         Bin centers in nominal meters (no sound speed profile
correction).\n",
			"tr_temp       ADCP transducer temperature.\n",
			"pg            Percent Good pings for u, v averaging after editing.\n",
			"pflag         Profile Flags based on editing, used to mask u, v.\n",
			"amp           Received signal strength in ADCP-specific units; no
correction\n",
			"              for spreading or attenuation.\n",
	"================================================================================\n",
			"\n",
			"" ;
		:CODAS_processing_note = "\n",
			"CODAS processing note:\n",
			"======================\n",
			"\n",
			"Overview\n",
			"--------\n",
			"The CODAS database is a specialized storage format designed for\n",
			"shipboard ADCP data.  \"CODAS processing\" uses this format to hold\n",
			"averaged shipboard ADCP velocities and other variables, during the\n",
			"stages of data processing.  The CODAS database stores velocity\n",
			"profiles relative to the ship as east and north components along with\n",
			"position, ship speed, heading, and other variables. The netCDF *short*\n",
			"form contains ocean velocities relative to earth, time, position,\n",
			"transducer temperature, and ship heading; these are designed to be\n",
			"\"ready for immediate use\".  The netCDF *long* form is just a dump of\n",
			"the entire CODAS database.  Some variables are no longer used, and all\n",
			"have names derived from their original CODAS names, dating back to the\n",
```

```
"late 1980\'s.\n",
"\n",
"Post-processing\n",
"---------------\n",
"CODAS post-processing, i.e. that which occurs after the single-ping\n",
"profiles have been vector-averaged and loaded into the CODAS database,\n",
"includes editing (using automated algorithms and manual tools),\n",
"rotation and scaling of the measured velocities, and application of a\n",
"time-varying heading correction.  Additional algorithms developed more\n",
"recently include translation of the GPS positions to the transducer\n",
"location, and averaging of ship\'s speed over the times of valid pings\n",
"when Percent Good is reduced. Such post-processing is needed prior to\n",
"submission of \"processed ADCP data\" to JASADCP or other archives.\n",
"\n",
"Full CODAS processing\n",
"---------------------\n",
"Whenever single-ping data have been recorded, full CODAS processing\n",
"provides the best end product.\n",
"\n",
"Full CODAS processing starts with the single-ping velocities in beam\n",
"coordinates.  Based on the transducer orientation relative to the\n",
"hull, the beam velocities are transformed to horizontal, vertical, and\n",
"\"error velocity\" components.  Using a reliable heading (typically from\n",
"the ship\'s gyro compass), the velocities in ship coordinates are\n",
"rotated into earth coordinates.\n",
"\n",
"Pings are grouped into an \"ensemble\" (usually 2-5 minutes duration)\n",
"and undergo a suite of automated editing algorithms (removal of\n",
"acoustic interference; identification of the bottom; editing based on\n",
"thresholds; and specialized editing that targets CTD wire interference\n",
"and \"weak, biased profiles\".  The ensemble of single-ping velocities\n",
"is then averaged using an iterative reference layer averaging scheme.\n",
"Each ensemble is approximated as a single function of depth, with a\n",
"zero-average over a reference layer plus a reference layer velocity\n",
"for each ping.  Adding the average of the single-ping reference layer\n",
"velocities to the function of depth yields the ensemble-average\n",
"velocity profile.  These averaged profiles, along with ancillary\n",
"measurements, are written to disk, and subsequently loaded into the\n",
"CODAS database. Everything after this stage is \"post-processing\".\n",
"\n",
"note (time):\n",
"------------\n",
"Time is stored in the database using UTC Year, Month, Day, Hour,\n",
"Minute, Seconds.  Floating point time \"Decimal Day\" is the floating\n",
"point interval in days since the start of the year, usually the year\n",
"of the first day of the cruise.\n",
"\n",
"\n",
```

```
                        "note (heading):\n",
                        "---------------\n",
                        "CODAS processing uses heading from a reliable device, and (if\n",
                        "available) uses a time-dependent correction by an accurate heading\n",
                        "device.  The reliable heading device is typically a gyro compass (for\n",
                        "example, the Bridge gyro).  Accurate heading devices can be POSMV,\n",
                        "Seapath, Phins, Hydrins, MAHRS, or various Ashtech devices; this\n",
                        "varies with the technology of the time.  It is always confusing to\n",
                        "keep track of the sign of the heading correction.  Headings are written\n",
                        "degrees, positive clockwise. setting up some variables:\n",
                        "\n",
                        "X = transducer angle (CONFIG1_heading_bias)\n",
                        "    positive clockwise (beam 3 angle relative to ship)\n",
                        "G = Reliable heading (gyrocompass)\n",
                        "A = Accurate heading\n",
                        "dh = G - A = time-dependent heading correction
(ANCIL2_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",
                    "" ;
}
```

```
netcdf in2022_v09_os150nb {
dimensions:
        time = 4515 ;
        depth_cell = 60 ;
variables:
        int trajectory ;
                trajectory:standard_name = "trajectory_id" ;
        double time(time) ;
                time:long_name = "Decimal day" ;
                time:units = "days since 2022-01-01 00:00:00" ;
                time:C_format = "%12.5f" ;
                time:standard_name = "time" ;
                time:data_min = 322.223726851852 ;
                time:data_max = 352.1334375 ;
        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 = 110.339141666667 ;
                lon:data_max = 115.703888888889 ;
        double lat(time) ;
                lat:missing_value = 1.e+38 ;
                lat:long_name = "Latitude" ;
                lat:units = "degrees_north" ;
                lat:C_format = "%9.4f" ;
                lat:standard_name = "latitude" ;
                lat:data_min = -32.1993277777778 ;
                lat:data_max = -20.7905277777778 ;
```

```
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 = 17.94f ;
        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 = -0.781486f ;
        u:data_max = 0.9167347f ;
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 = -1.345887f ;
        v:data_max = 0.7402601f ;
short amp(time, depth_cell) ;
        amp:missing_value = 32767s ;
        amp:long_name = "Received signal strength" ;
        amp:C_format = "%d" ;
        amp:data_min = 21s ;
        amp:data_max = 228s ;
byte pg(time, depth_cell) ;
        pg:missing_value = -1b ;
        pg:long_name = "Percent good pings" ;
        pg:C_format = "%d" ;
        pg:data_min = 0b ;
        pg:data_max = 100b ;
byte pflag(time, depth_cell) ;
        pflag:long_name = "Editing flags" ;
        pflag:C_format = "%d" ;
        pflag:data_min = 0b ;
        pflag:data_max = 6b ;
float heading(time) ;
        heading:missing_value = 1.e+38f ;
        heading:long_name = "Ship heading" ;
        heading:units = "degrees" ;
        heading:C_format = "%6.1f" ;
        heading:data_min = -179.9653f ;
        heading:data_max = 179.9903f ;
float tr_temp(time) ;
        tr_temp:missing_value = 1.e+38f ;
```

```
		tr_temp:long_name = "ADCP transducer temperature" ;
		tr_temp:units = "Celsius" ;
		tr_temp:C_format = "%4.1f" ;
		tr_temp:data_min = 18.98634f ;
		tr_temp:data_max = 26.24741f ;
	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 = 28s ;
		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 = -6.64149f ;
		uship:data_max = 6.137169f ;
	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 = -6.427855f ;
		vship:data_max = 6.311141f ;

// global attributes:
		:featureType = "trajectoryProfile" ;
		:history = "Created: 2023-02-17 04:00:12 UTC" ;
		:Conventions = "COARDS" ;
		:software = "pycurrents" ;
		:hg_changeset = "3211:63370479787a" ;
		:title = "Shipboard ADCP velocity profiles" ;
		:description = "Shipboard ADCP velocity profiles from in2022_v09 using instrument
os150nb - Short Version." ;
		:cruise_id = "in2022_v09" ;
		:sonar = "os150nb" ;
		:yearbase = 2022 ;
		:ship_name = "RV Investigator" ;
		:CODAS_variables = "\n",
			"Variables in this CODAS short-form Netcdf file are intended for most end-
user\n",
			"scientific analysis and display purposes. For additional information see\n",
			"the CODAS_processing_note global attribute and the attributes of each\n",
			"of the variables.\n",
			"\n",
			"\n",

	"================================================================================\n",
```

```
                    "time          Time at the end of the ensemble, days from start of year.\n",
                    "lon, lat      Longitude, Latitude from GPS at the end of the ensemble.\n",
                    "u,v           Ocean zonal and meridional velocity component profiles.\n",
                    "uship, vship  Zonal and meridional velocity components of the ship.\n",
                    "heading       Mean ship heading during the ensemble.\n",
                    "depth         Bin centers in nominal meters (no sound speed profile
correction).\n",
                    "tr_temp       ADCP transducer temperature.\n",
                    "pg            Percent Good pings for u, v averaging after editing.\n",
                    "pflag         Profile Flags based on editing, used to mask u, v.\n",
                    "amp           Received signal strength in ADCP-specific units; no
correction\n",
                    "              for spreading or attenuation.\n",

      "================================================================================\n",
                    "\n",
                    "" ;
             :CODAS_processing_note = "\n",
                    "CODAS processing note:\n",
                    "======================\n",
                    "\n",
                    "Overview\n",
                    "--------\n",
                    "The CODAS database is a specialized storage format designed for\n",
                    "shipboard ADCP data.  \"CODAS processing\" uses this format to hold\n",
                    "averaged shipboard ADCP velocities and other variables, during the\n",
                    "stages of data processing.  The CODAS database stores velocity\n",
                    "profiles relative to the ship as east and north components along with\n",
                    "position, ship speed, heading, and other variables. The netCDF *short*\n",
                    "form contains ocean velocities relative to earth, time, position,\n",
                    "transducer temperature, and ship heading; these are designed to be\n",
                    "\"ready for immediate use\".  The netCDF *long* form is just a dump of\n",
                    "the entire CODAS database.  Some variables are no longer used, and all\n",
                    "have names derived from their original CODAS names, dating back to the\n",
                    "late 1980\'s.\n",
                    "\n",
                    "Post-processing\n",
                    "---------------\n",
                    "CODAS post-processing, i.e. that which occurs after the single-ping\n",
                    "profiles have been vector-averaged and loaded into the CODAS database,\n",
                    "includes editing (using automated algorithms and manual tools),\n",
                    "rotation and scaling of the measured velocities, and application of a\n",
                    "time-varying heading correction.  Additional algorithms developed more\n",
                    "recently include translation of the GPS positions to the transducer\n",
                    "location, and averaging of ship\'s speed over the times of valid pings\n",
                    "when Percent Good is reduced. Such post-processing is needed prior to\n",
                    "submission of \"processed ADCP data\" to JASADCP or other archives.\n",
                    "\n",
                    "Full CODAS processing\n",
```

```
"---------------------\n",
"Whenever single-ping data have been recorded, full CODAS processing\n",
"provides the best end product.\n",
"\n",
"Full CODAS processing starts with the single-ping velocities in beam\n",
"coordinates.  Based on the transducer orientation relative to the\n",
"hull, the beam velocities are transformed to horizontal, vertical, and\n",
"\"error velocity\" components.  Using a reliable heading (typically from\n",
"the ship\'s gyro compass), the velocities in ship coordinates are\n",
"rotated into earth coordinates.\n",
"\n",
"Pings are grouped into an \"ensemble\" (usually 2-5 minutes duration)\n",
"and undergo a suite of automated editing algorithms (removal of\n",
"acoustic interference; identification of the bottom; editing based on\n",
"thresholds; and specialized editing that targets CTD wire interference\n",
"and \"weak, biased profiles\".  The ensemble of single-ping velocities\n",
"is then averaged using an iterative reference layer averaging scheme.\n",
"Each ensemble is approximated as a single function of depth, with a\n",
"zero-average over a reference layer plus a reference layer velocity\n",
"for each ping.  Adding the average of the single-ping reference layer\n",
"velocities to the function of depth yields the ensemble-average\n",
"velocity profile.  These averaged profiles, along with ancillary\n",
"measurements, are written to disk, and subsequently loaded into the\n",
"CODAS database. Everything after this stage is \"post-processing\".\n",
"\n",
"note (time):\n",
"------------\n",
"Time is stored in the database using UTC Year, Month, Day, Hour,\n",
"Minute, Seconds.  Floating point time \"Decimal Day\" is the floating\n",
"point interval in days since the start of the year, usually the year\n",
"of the first day of the cruise.\n",
"\n",
"\n",
"note (heading):\n",
"---------------\n",
"CODAS processing uses heading from a reliable device, and (if\n",
"available) uses a time-dependent correction by an accurate heading\n",
"device.  The reliable heading device is typically a gyro compass (for\n",
"example, the Bridge gyro).  Accurate heading devices can be POSMV,\n",
"Seapath, Phins, Hydrins, MAHRS, or various Ashtech devices; this\n",
"varies with the technology of the time.  It is always confusing to\n",
"keep track of the sign of the heading correction.  Headings are written\n",
"degrees, positive clockwise. setting up some variables:\n",
"\n",
"X = transducer angle (CONFIG1_heading_bias)\n",
"    positive clockwise (beam 3 angle relative to ship)\n",
"G = Reliable heading (gyrocompass)\n",
"A = Accurate heading\n",
```

```
                    "dh = G - A = time-dependent heading correction(ANCIL2_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

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