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RV *Investigator* ADCP Data Processing Report

Voyage ID	IN2024_V05
Voyage Title	SEA-MES: Untangling the causes of change over 25 years in the southeast marine ecosystem - Voyage 3
Depart	Hobart, 12 November 2024, 22:30 UTC
Return	Hobart, 12 December 2024, 22:30 UTC
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Document History

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1 Summary

Southeast Australia's marine waters are a global hotspot, experiencing rapid warming due to the expanding East Australian Current, which is four times the global average. Species are shifting southward, and extreme events like marine heatwaves are adding further impacts. These changes are expected to continue. The Australian Commonwealth Southeast Marine Park Network (SE-MPN), established in 2012, aims to protect the region's marine biodiversity, but it's unclear how ecosystem changes are affecting the parks. In 2015, experts recommended adaptive management strategies, including research and monitoring frameworks for better decision-making. The region is also home to vital fisheries, such as the Southern and Eastern Scalefish and Shark Fishery (SESSF), which have seen declines in key species and shifts in fish composition. The Southeast Australian Marine Ecosystem Survey (SEA-MES) voyage three, aims to document changes and establish a baseline to address questions about species changes, marine park management, and the implications for marine planning. The survey will also test new techniques for monitoring seabirds using an AI camera system.

The previous ecosystem survey took place 25 years ago, and this project aims to repeat it to document changes and establish a new biological and environmental baseline. The study will explore three key questions:

1. What factors have caused changes in fish populations and species abundance in the southeast ecosystem, and can these causes be addressed?
2. How do these changes influence the management of the region, particularly in terms of conservation and biodiversity within Australian Marine Parks, as well as the activities of fisheries, oil & gas, and renewable energy industries?
3. What are the implications of these changes for marine spatial planning and adaptive management in these sectors?

This report describes the production of quality controlled ADCP data from RV *Investigator* voyage IN2024_V05.

The ADCP was run for most of the voyage, though it was turned off when EK80 surveys were being performed to avoid creating interference in the EK80 data. As this was a fisheries voyage, the EK80 was used extensively and the ADCPs were not acquiring for long periods throughout the voyage.

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 150kHz ADCP, RDI Ocean Surveyor 75kHz ADCP and RDI Ocean Surveyor 38kHz ADCP were run in narrowband mode.

Internal triggering was used.

The drop keel was set at 2 metres below the hull for the duration of the voyage. The nominal transducer depth is set to 6 metres, any additional changes will need to be applied by the user if they believe it is required.

Bottom tracking was run for an hour of the voyage on the OS150nb to aid in calibrations.

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

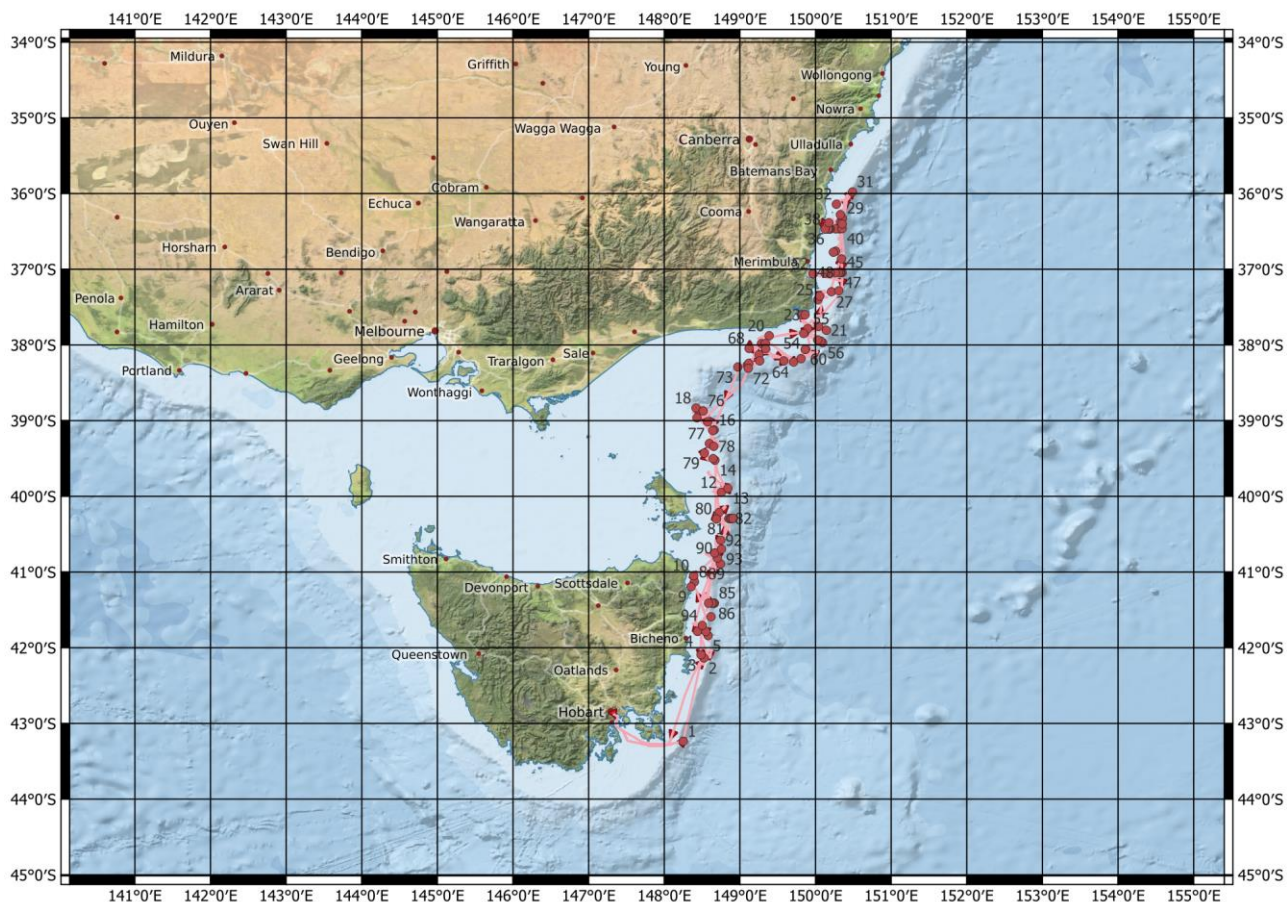


Figure 1: Voyage track with locations of CTD stations numbered by CTD deployment

Please see the webpy folders for plots of collected data.

2 Data Processing

2.1 Background Information

The University of Hawaii’s CODAS software with changeset number 3389:2fa0841853b2 was used for data post-processing.

The ADCP beam velocities are rotated into earth coordinates using the reliable source (gyro) for heading. CODAS processing corrects the reliable headings to accurate values by a timeseries of the difference between the accurate and reliable heading devices. The accurate heading for this voyage is either the Seapath or Posmv. Errors in this timeseries will occur if the accurate heading device drops out. Patch_hcorr.py interpolates gaps in the heading correction timeseries and is run if small gaps are found.

Additional adjustments to scale factor and angle are needed if water track calibration residuals are out of tolerance. The aim is to get errors due to bad angle or scale factor down to the level of 1cm/s error in the ADCP measurements, the target for residuals

- Amplitude: 0.995 to 1.005
- Phase/Angle: -0.04 to +0.04

Manual calibration corrections with `quick_adcp.py` (`rotate_amplitude` and `rotate_angle`) have been applied to the data if the watertrack calibration residuals have sufficient points for reasonable statistics (>12-15 edited). If there are insufficient watertrack points (eg. a transit), values from adjacent voyages are used.

Manual editing with `dataviewer.py` was used to remove in water artifacts (e.g. scattering layers, depth below bottom, etc). This can affect watertrack calibration residuals (mostly in scale factor), so check a final application of residuals may be applied.

2.2 Processing Notes

The calibration corrections for the OS150nb and OS75nb could not be brought into the desirable range for Phase between -0.04 to +0.04, for both the Watertrack and Bottomtrack Phase. As such, corrections were made to bring the Watertrack Phase into the desirable range at the cost of putting the Bottomtrack out. This issue was potentially caused by Drop Keel movement while the ADCP was acquiring.

The OS75 Phase Median and Mean value could not both be corrected to within -0.04 to +0.04. Only the median was corrected to be within the desirable range. See Table 4 in Appendix A for details.

OS38nb data was not processed, as very little data was collected. The small amount of data collected with the OS38nb shows a depth less than roughly 800m, for which OS150nb and OS75nb data was acquired and processed.

2.2.1 Calibration Residuals

Small gaps of lost data in the accurate heading device were found, hence Table 1 and 5 in Appendix A shows the changes to the residual before and after “`patch_hcorr.py`” was run to interpolate the heading correction through the gaps. Table 1 shows the final calibration corrections and residuals.

Table 1: Correction and Residual Value Summary, see Appendix A

	OS150nb	OS75nb	OS38nb
Data Date Range	13 Nov 2024 05:58 - 11 Dec 2024 02:02	13 Nov 2024 05:58 - 08 Dec 2024 00:30	N/A
Final Phase/Angle Correction	0.28	1.051	N/A
Final Amplitude Correction	1.006	1.006	N/A

		Water Track	Bottom Track	Water Track	Bottom Track	Water Track	Bottom Track
Number of edited points		23/36	110/890	13/19	32/528	N/A	N/A
Final Amplitude Residual	Mean	1.0021	0.9992	1.0039	0.9970	N/A	N/A
	Median	1.002	0.9993	1.0030	0.9984	N/A	N/A
Final Phase/Angle Residual	Mean	0.0349	-0.2593	0.0483	-0.7700	N/A	N/A
	Median	-0.0010	-0.2522	-0.0400	-0.7573	N/A	N/A

2.2.2 Offsets

The offset from the ADCP transducer to the GPS needs to be known to avoid errors when the ship is turning, see Appendix for a visual representation of why this is important. The offsets when processing are shown in Table 2.

Table 2: GPS to ADCP Offsets

	OS150	OS75	OS38
dx (m)	1	1	1
dy (m)	8	13	10

2.3 Instrument Serial Numbers

Table 3: Instrument Serial Numbers

Manufacturer	Instrument	Serial Number
TRDI	ADCP 150 kHz	61315
TRDI	ADCP 75 kHz	65008
TRDI	ADCP 38 kHz	671923

3 NetCDF Data Headers

```
netcdf in2024_v05_os150nb {
```

```
dimensions:
```

```
    time = 1590 ;
```

```
    depth_cell = 60 ;
```

```
    num_configs = 91 ;
```

variables:

```
double time(time) ;
    time:long_name = "Decimal day" ;
    time:units = "days since 2024-01-01 00:00:00" ;
    time:C_format = "%12.5f" ;
    time:standard_name = "time" ;
    time:calendar = "proleptic_gregorian" ;
    time:axis = "T" ;
    time:data_min = 317.249039351852 ;
    time:data_max = 345.085266203704 ;

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 = 148.249838888889 ;
    lon:data_max = 150.490591666667 ;

double lat(time) ;
    lat:missing_value = 1.e+38 ;
    lat:long_name = "Latitude" ;
    lat:units = "degrees_north" ;
    lat:C_format = "%9.4f" ;
    lat:standard_name = "latitude" ;
    lat:data_min = -43.2396333333333 ;
    lat:data_max = -35.9797361111111 ;

float depth(time, depth_cell) ;
    depth:missing_value = 1.e+38f ;
    depth:long_name = "Depth" ;
    depth:units = "meter" ;
    depth:C_format = "%8.2f" ;
    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 = -0.4791588f ;
    u:data_max = 0.5699356f ;

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 = -1.396626f ;
    v:data_max = 0.4231142f ;

short amp(time, depth_cell) ;
    amp:missing_value = 32767s ;
    amp:long_name = "Received signal strength" ;
    amp:units = "" ;
    amp:C_format = "%d" ;
    amp:data_min = 33s ;
    amp:data_max = 227s ;

byte pg(time, depth_cell) ;
    pg:missing_value = -1b ;
    pg:long_name = "Percent good pings" ;
    pg:units = "" ;
    pg:C_format = "%d" ;
    pg:data_min = 0b ;
    pg:data_max = 100b ;

byte pflag(time, depth_cell) ;
    pflag:long_name = "Editing flags" ;
    pflag:units = "" ;
    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 = -179.7856f ;  
    heading:data_max = 179.5333f ;  
float tr_temp(time) ;  
    tr_temp:missing_value = 1.e+38f ;  
    tr_temp:long_name = "ADCP transducer temperature" ;  
    tr_temp:units = "degree_Celsius" ;  
    tr_temp:C_format = "%4.1f" ;  
    tr_temp:data_min = 14.07435f ;  
    tr_temp:data_max = 21.508f ;  
short num_pings(time) ;  
    num_pings:long_name = "Number of pings averaged per ensemble" ;  
    num_pings:units = "" ;  
    num_pings:C_format = "%d" ;  
    num_pings:data_min = 11s ;  
    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 = -6.288335f ;  
    uship:data_max = 5.011046f ;  
float vship(time) ;  
    vship:missing_value = 1.e+38f ;  
    vship:long_name = "Ship meridional velocity component" ;  
    vship:units = "meter second-1" ;  
    vship:C_format = "%9.4f" ;
```

```

vship:data_min = -4.675695f ;
vship:data_max = 5.208028f ;
int index_config_start(num_configs) ;
    index_config_start:long_name = "First zero-based time index of each configuration"
;

    index_config_start:units = "" ;
float ensemble_seconds(num_configs) ;
    ensemble_seconds:long_name = "Ensemble average duration" ;
    ensemble_seconds:units = "s" ;
short num_depth_bins(num_configs) ;
    num_depth_bins:long_name = "Number of depth bins" ;
    num_depth_bins:units = "" ;
float transducer_depth(num_configs) ;
    transducer_depth:long_name = "Transducer depth" ;
    transducer_depth:units = "m" ;
float depth_bin_length(num_configs) ;
    depth_bin_length:long_name = "Vertical averaging length" ;
    depth_bin_length:units = "m" ;
float pulse_length(num_configs) ;
    pulse_length:long_name = "Vertical span of sonar ping" ;
    pulse_length:units = "m" ;
float blank_length(num_configs) ;
    blank_length:long_name = "Vertical delay between ping and first reception" ;
    blank_length:units = "m" ;
float ping_interval(num_configs) ;
    ping_interval:long_name = "Typical time between pings" ;
    ping_interval:units = "s" ;
float transducer_orientation(num_configs) ;
    transducer_orientation:long_name = "Approximate transducer orientation,
clockwise rotation of beam 3 from forward" ;
    transducer_orientation:units = "degrees" ;

```

```
// global attributes:
```

```

:history = "Created: 2025-06-24 23:44:32 UTC" ;
:Conventions = "COARDS CF-1.8" ;
:software = "pycurrents" ;
:hg_changeset = "3389:2fa0841853b2" ;
:title = "Shipboard ADCP velocity profiles" ;
:summary = "Shipboard ADCP velocity profiles from in2024_v05 using instrument
os150nb - Short Version." ;
:cruise_id = "in2024_v05" ;
:sonar = "os150nb" ;
:yearbase = 2024 ;
:platform = "RV Investigator" ;
:time_coverage_start = "2024-11-13T05:58:37Z" ;
:time_coverage_end = "2024-12-11T02:02:47Z" ;
:geospatial_lat_min = -43.23963f ;
:geospatial_lat_max = -35.97974f ;
:geospatial_lat_units = "degrees_north" ;
:geospatial_lon_min = 148.2498f ;
:geospatial_lon_max = 150.4906f ;
:geospatial_lon_units = "degrees_east" ;
:geospatial_vertical_min = 17.93f ;
:geospatial_vertical_max = 490.f ;
:geospatial_vertical_units = "m" ;
:geospatial_vertical_positive = "down" ;
:CODAS_variables = "\n",
    "Variables in this CODAS short-form Netcdf file are intended for most end-
user\n",
    "scientific analysis and display purposes. For additional information see\n",
    "the CODAS_processing_note global attribute and the attributes of each\n",
    "of the variables.\n",
    "\n",
    "\n",
    "=====\n",
    "=====\n",
    "time      Time at the end of the ensemble, days from start of year.\n",

```

```

"lon, lat    Longitude, Latitude from GPS at the end of the ensemble.\n",
"u,v        Ocean eastward and northward velocity component profiles.\n",
"uship, vship Eastward and northward 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 after editing in vector-averaged velocities.\n",
"pflag     Profile Flags based on editing, used to mask velocities.\n",
"amp       Received signal strength in ADCP-specific units; no correction\n",
"          for spreading or attenuation.\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 $(u+iv) \cdot (\exp(i \cdot \theta))$ where θ is the sum of the\n",
 "corrected heading and the transducer angle.\n",
 "\n",
 $\theta = X + (G - dh) = X + G - dh$ \n",
 "\n",
 "\n",
 "Watertrack and Bottomtrack calibrations give an indication of the\n",
 "residual angle offset to apply, for example if mean and median of the\n",
 "phase are all 0.5 (then $R=0.5$). Using the \"rotate\" command,\n",
 "the value of R is added to \"ANCIL2_watr_k_hd_misalign\".\n",
 "\n",
 $new_dh = dh + R$ \n",
 "\n",
 "Therefore the total angle used in rotation is\n",
 "\n",
 $new_theta = X + G - dh_new$ \n",
 $= X + G - (dh + R)$ \n",
 $= (X - R) + (G - dh)$ \n",
 "\n",
 "The new estimate of the transducer angle is: $X - R$ \n",
 "ANCIL2_watr_k_hd_misalign contains: $dh + R$ \n",
 "\n",
 "=====\n",
 "\n",
 "Profile flags\n",
 "-----\n",
 "Profile editing flags are provided for each depth cell:\n",
 "\n",
 "binary decimal below Percent\n",
 "value value bottom Good bin\n",
 "-----+-----+-----+-----+-----+\n"

```

"000  0\n",
"001  1          bad\n",
"010  2          bad\n",
"011  3          bad  bad\n",
"100  4  bad\n",
"101  5  bad      bad\n",
"110  6  bad  bad\n",
"111  7  bad  bad  bad\n",
"-----+-----+-----+-----+-----+\n",
"" ;

```

```

}

```

```

netcdf in2024_v05_os75nb {

```

```

dimensions:

```

```

    time = 1053 ;

```

```

    depth_cell = 55 ;

```

```

    num_configs = 63 ;

```

```

variables:

```

```

    double time(time) ;

```

```

        time:long_name = "Decimal day" ;

```

```

        time:units = "days since 2024-01-01 00:00:00" ;

```

```

        time:C_format = "%12.5f" ;

```

```

        time:standard_name = "time" ;

```

```

        time:calendar = "proleptic_gregorian" ;

```

```

        time:axis = "T" ;

```

```

        time:data_min = 317.249039351852 ;

```

```

        time:data_max = 342.021342592593 ;

```

```

    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 = 148.249797222222 ;

```

```
lon:data_max = 150.490627777778 ;
double lat(time) ;
    lat:missing_value = 1.e+38 ;
    lat:long_name = "Latitude" ;
    lat:units = "degrees_north" ;
    lat:C_format = "%9.4f" ;
    lat:standard_name = "latitude" ;
    lat:data_min = -43.2396666666667 ;
    lat:data_max = -35.9797083333333 ;
float depth(time, depth_cell) ;
    depth:missing_value = 1.e+38f ;
    depth:long_name = "Depth" ;
    depth:units = "meter" ;
    depth:C_format = "%8.2f" ;
    depth:data_min = 29.94f ;
    depth:data_max = 893.99f ;
float u(time, depth_cell) ;
    u:missing_value = 1.e+38f ;
    u:long_name = "Zonal velocity component" ;
    u:units = "meter second-1" ;
    u:C_format = "%7.2f" ;
    u:data_min = -0.6065847f ;
    u:data_max = 0.5721053f ;
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 = -1.00144f ;
    v:data_max = 0.4315832f ;
short amp(time, depth_cell) ;
    amp:missing_value = 32767s ;
    amp:long_name = "Received signal strength" ;
```

```
amp:units = "" ;
amp:C_format = "%d" ;
amp:data_min = 13s ;
amp:data_max = 192s ;
byte pg(time, depth_cell) ;
pg:missing_value = -1b ;
pg:long_name = "Percent good pings" ;
pg:units = "" ;
pg:C_format = "%d" ;
pg:data_min = 0b ;
pg:data_max = 100b ;
byte pflag(time, depth_cell) ;
pflag:long_name = "Editing flags" ;
pflag:units = "" ;
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 = -179.5308f ;
heading:data_max = 179.5372f ;
float tr_temp(time) ;
tr_temp:missing_value = 1.e+38f ;
tr_temp:long_name = "ADCP transducer temperature" ;
tr_temp:units = "degree_Celsius" ;
tr_temp:C_format = "%4.1f" ;
tr_temp:data_min = 14.10128f ;
tr_temp:data_max = 21.87231f ;
short num_pings(time) ;
num_pings:long_name = "Number of pings averaged per ensemble" ;
```

```

num_pings:units = "" ;
num_pings:C_format = "%d" ;
num_pings:data_min = 10s ;
num_pings:data_max = 145s ;
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 = -6.289021f ;
    uship:data_max = 4.304288f ;
float vship(time) ;
    vship:missing_value = 1.e+38f ;
    vship:long_name = "Ship meridional velocity component" ;
    vship:units = "meter second-1" ;
    vship:C_format = "%9.4f" ;
    vship:data_min = -4.277193f ;
    vship:data_max = 3.808117f ;
int index_config_start(num_configs) ;
    index_config_start:long_name = "First zero-based time index of each configuration"
;
    index_config_start:units = "" ;
float ensemble_seconds(num_configs) ;
    ensemble_seconds:long_name = "Ensemble average duration" ;
    ensemble_seconds:units = "s" ;
short num_depth_bins(num_configs) ;
    num_depth_bins:long_name = "Number of depth bins" ;
    num_depth_bins:units = "" ;
float transducer_depth(num_configs) ;
    transducer_depth:long_name = "Transducer depth" ;
    transducer_depth:units = "m" ;
float depth_bin_length(num_configs) ;
    depth_bin_length:long_name = "Vertical averaging length" ;

```

```

    depth_bin_length:units = "m" ;
float pulse_length(num_configs) ;
    pulse_length:long_name = "Vertical span of sonar ping" ;
    pulse_length:units = "m" ;
float blank_length(num_configs) ;
    blank_length:long_name = "Vertical delay between ping and first reception" ;
    blank_length:units = "m" ;
float ping_interval(num_configs) ;
    ping_interval:long_name = "Typical time between pings" ;
    ping_interval:units = "s" ;
float transducer_orientation(num_configs) ;
    transducer_orientation:long_name = "Approximate transducer orientation,
clockwise rotation of beam 3 from forward" ;
    transducer_orientation:units = "degrees" ;

// global attributes:
:history = "Created: 2025-06-24 23:34:44 UTC" ;
:Conventions = "COARDS CF-1.8" ;
:software = "pycurrents" ;
:hg_changeset = "3389:2fa0841853b2" ;
:title = "Shipboard ADCP velocity profiles" ;
:summary = "Shipboard ADCP velocity profiles from in2024_v05 using instrument
os75nb - Short Version." ;
:cruise_id = "in2024_v05" ;
:sonar = "os75nb" ;
:yearbase = 2024 ;
:platform = "RV Investigator" ;
:time_coverage_start = "2024-11-13T05:58:37Z" ;
:time_coverage_end = "2024-12-08T00:30:44Z" ;
:geospatial_lat_min = -43.23967f ;
:geospatial_lat_max = -35.97971f ;
:geospatial_lat_units = "degrees_north" ;
:geospatial_lon_min = 148.2498f ;

```

```

:geospatial_lon_max = 150.4906f ;
:geospatial_lon_units = "degrees_east" ;
:geospatial_vertical_min = 29.94f ;
:geospatial_vertical_max = 893.99f ;
:geospatial_vertical_units = "m" ;
:geospatial_vertical_positive = "down" ;
: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 eastward and northward velocity component profiles.\n",
    "uship, vship Eastward and northward 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 after editing in vector-averaged velocities.\n",
    "pflag      Profile Flags based on editing, used to mask velocities.\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 $(u+iv) \cdot (\exp(i \cdot \theta))$ 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_watrkh_hd_misalign contains: dh + R\n",
"\n",
"=====\n",
"\n",
"Profile flags\n",
"-----\n",
"Profile editing flags are provided for each depth cell:\n",
"\n",
"binary  decimal  below  Percent\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

Little, R. (2024). *The RV Investigator. Voyage Plan IN2024_V05*. Retrieved from Marine National Facility: Voyage Plans and summaries: https://www.cmar.csiro.au/data/reporting/get_file.cfm?eov_pub_id=3549

Hummon, J. (2009-2021). *CODAS+UHDAS Documentation*. Retrieved February 1, 2023, from <https://doi.org/10.5281/zenodo.8371260>

5 Appendix A

Table 4: os150nb Water Track and Bottom Track Working Calibrations and Residuals

Water Track	Bottom Track
Preliminary	
Number of edited points: 23 out of 38 <div style="text-align: center;">median mean std</div> amplitude 1.0090 1.0100 0.0122 phase 0.2890 0.2960 0.6735	unedited: 781 points edited: 111 points, 2.0 min speed, 2.5 max dev <div style="text-align: center;">median mean std</div> amplitude 1.0054 1.0054 0.0030 phase 0.0274 0.0166 0.1105
After patch_hcorr.py	
Number of edited points: 23 out of 38 <div style="text-align: center;">median mean std</div> amplitude 1.0090 1.0100 0.0122 phase 0.2890 0.2960 0.6735	unedited: 781 points edited: 111 points, 2.0 min speed, 2.5 max dev <div style="text-align: center;">median mean std</div> amplitude 1.0054 1.0054 0.0030 phase 0.0274 0.0166 0.1105
Calibrations correction values applied	
rotate_amplitude: N/A	
rotate_angle: 0.16, 0.114, -0.03	
After applying calibration corrections	
Number of edited points: 23 out of 38 <div style="text-align: center;">median mean std</div> amplitude 1.0080 1.0103 0.0120 phase 0.0280 0.0584 0.6734	unedited: 780 points edited: 111 points, 2.0 min speed, 2.5 max dev <div style="text-align: center;">median mean std</div> amplitude 1.0055 1.0053 0.0030 phase -0.2221 -0.2267 0.1070
After manual single ping editing	
Number of edited points: 23 out of 36 <div style="text-align: center;">median mean std</div> amplitude 1.0080 1.0081 0.0117 phase 0.0280 0.0700 0.6610	unedited: 780 points edited: 111 points, 2.0 min speed, 2.5 max dev <div style="text-align: center;">median mean std</div> amplitude 1.0055 1.0053 0.0030 phase -0.2221 -0.2267 0.1070
Calibrations correction values applied	
rotate_amplitude: 1.006	
rotate_angle: -0.03, -0.06, 0.126	
Final calibration correction	
Number of edited points: 23 out of 36 <div style="text-align: center;">median mean std</div> amplitude 1.0020 1.0021 0.0117 phase -0.0010 0.0349 0.6598	unedited: 780 points edited: 110 points, 2.0 min speed, 2.5 max dev <div style="text-align: center;">median mean std</div> amplitude 0.9993 0.9992 0.0030 phase -0.2522 -0.2593 0.0997

OS150nb_total_rotate_amplitude = 1.006

OS150nb_total_rotate_angle = 0.28

Table 5: os75nb Water Track and Bottom Track Working Calibrations and Residuals

Water Track	Bottom Track
Preliminary	
Number of edited points: 13 out of 19	unedited: 496 points
	edited: 32 points, 2.0 min speed, 2.5 max dev
median mean std	median mean std
amplitude 1.0070 1.0100 0.0137	amplitude 1.0046 1.0030 0.0062
phase 1.0090 1.0978 1.3874	phase 0.3185 0.2843 0.1931
After patch_hcorr.py	
Number of edited points: 13 out of 19	unedited: 496 points
	edited: 32 points, 2.0 min speed, 2.5 max dev
median mean std	median mean std
amplitude 1.0070 1.0100 0.0137	amplitude 1.0046 1.0030 0.0062
phase 1.0090 1.0978 1.3874	phase 0.3185 0.2843 0.1931
Calibrations correction values applied	
rotate_amplitude: 1.006	
rotate_angle: 1.09, -0.043, 0.02, -0.016, 0.01, -0.01	
After applying calibration corrections	
Number of edited points: 13 out of 19	unedited: 496 points
	edited: 32 points, 2.0 min speed, 2.5 max dev
median mean std	median mean std
amplitude 1.0030 1.0039 0.0135	amplitude 0.9984 0.9970 0.0063
phase -0.0400 0.0483 1.3868	phase -0.7573 -0.7700 0.1935
After manual single ping editing	
Number of edited points: 13 out of 19	unedited: 496 points
	edited: 32 points, 2.0 min speed, 2.5 max dev
median mean std	median mean std
amplitude 1.0030 1.0039 0.0135	amplitude 0.9984 0.9970 0.0063
phase -0.0400 0.0483 1.3868	phase -0.7573 -0.7700 0.1935

OS75nb_total_rotate_amplitude = 1.006

OS75nb_total_rotate_angle = 1.051

6 Appendix B

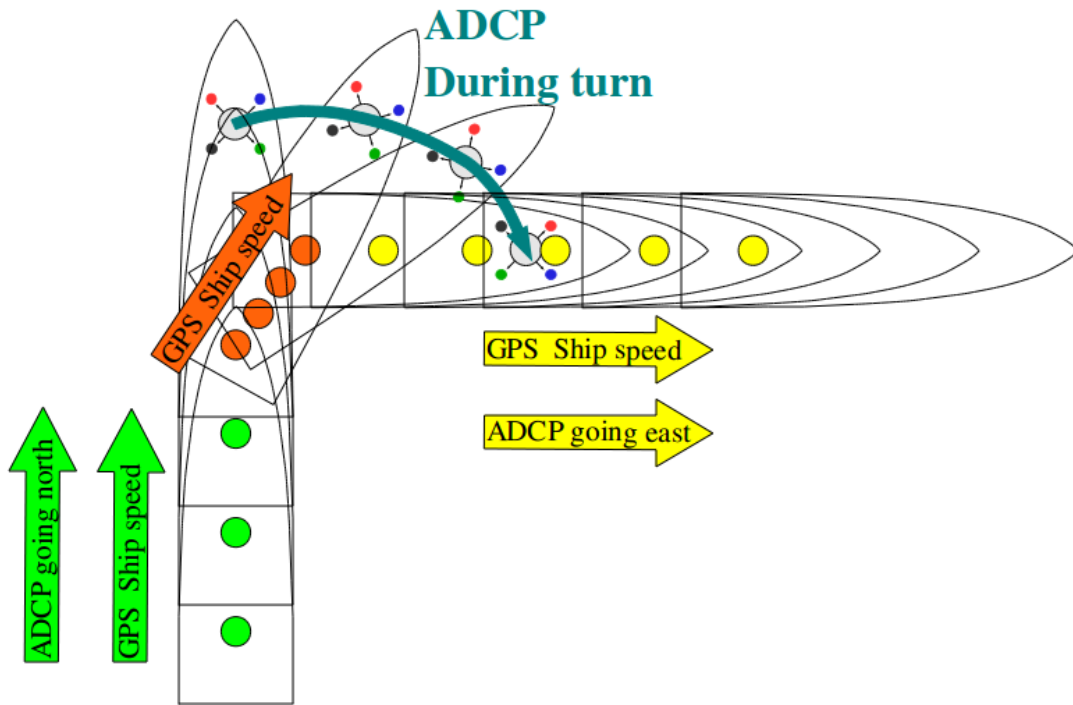


Figure 2: The horizontal offset between the ADCP transducer and the GPS (used to calculate ship speed) can cause errors in the calculated ocean velocity.

https://currents.soest.hawaii.edu/docs/adcp_doc/codas_doc/dataviewer/xducer_dxdy.html

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