Marine National Facility

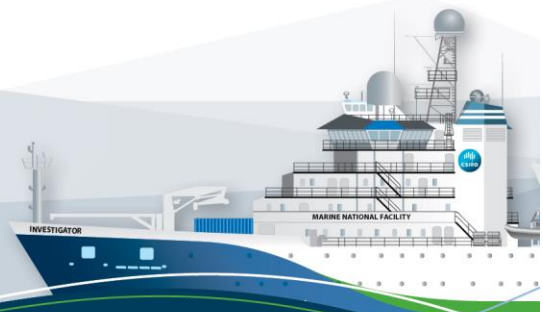
RV *Investigator*

ADCP Processing Report

Voyage:	IN2021_E01
Voyage title:	Equipment Calibrations 2021
Depart:	Hobart, 1000 AEDT Wednesday, 10 November 2021
Return:	Hobart, 1200 AEDT Sunday, 14 November 2021
Chief Scientist:	Jason Fazey
Affiliation:	CSIRO

Document History

Date	Version	Author	Comments
19 January 2021	1.0	Ella Pietraroia	Initial version
29 July 2026	2.0	Mark Brunton	Review and final revision for publication



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1 Summary

Data was collected during in2021_e01 for the duration of the voyage. Data was collected using UHDAS and post-processed using CODAS.

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

Internal triggering was used.

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

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

2 Processing Background

The University of Hawaii's CODAS software build dated May 2021 was used for data post-processing.

3 Processing Notes

ADCPs where turned off during calibrations of the EK80s and for patch testing of multibeams. The os75nb was turned off for the second half of the voyage due to the ship only being in shallow waters. Heading correction was used.

gbin directory containing gps/heading data is missing for this dataset. Phase/amplitude corrections were note applied.

Final water and bottom track amplitude and phase:

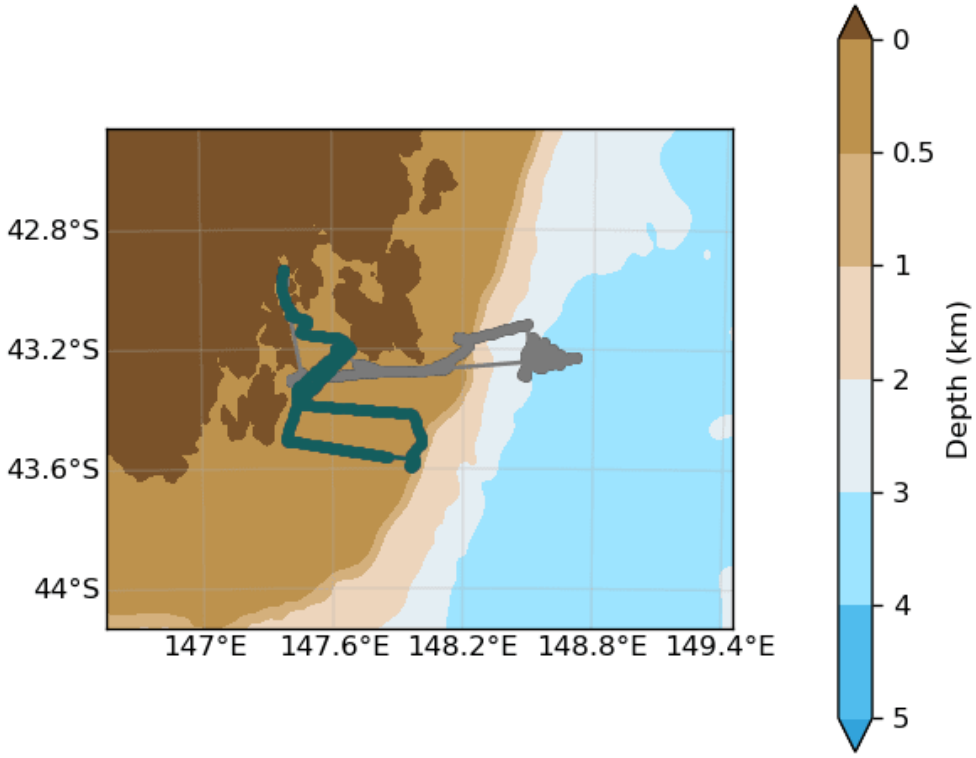
OS75				**OS150**			
Water-track		Bottom-track		Water-track		Bottom-track	
Amplitude	Phase	Amplitude	Phase	Amplitude	Phase	Amplitude	Phase
1.0065	0.2085	0.9999	0.0442	1.0105	0.1057	1.0052	0.1057

It was not possible to use bottom-track calibration for the OS75.

When processing the data, the true transducer offsets in metres from the GPS position of the ship in (meters) are as follows:

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

4 Area Covered



Please see the webpy_bb and webpy_nb folders for plots of collected data.

5 netCDF Data Headers

```
netcdf in2021_e01_os75nb {
dimensions:
        time = 640 ;
        depth_cell = 60 ;
variables:
        int trajectory ;
                trajectory:standard_name = "trajectory_id" ;
        double time(time) ;
                time:long_name = "Decimal day" ;
                time:units = "days since 2021-01-01 00:00:00" ;
                time:C_format = "%12.5f" ;
                time:standard_name = "time" ;
                time:data_min = 313.031701388889 ;
                time:data_max = 316.233391203704 ;
        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 = 147.377611111111 ;
lon:data_max = 148.716316666667 ;
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 = -43.3043361111111 ;
lat:data_max = -42.9715916666667 ;
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 = -0.4251003f ;
u:data_max = 0.6434913f ;
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 = -0.5915465f ;
v:data_max = 0.8484256f ;
short amp(time, depth_cell) ;
amp:missing_value = 32767s ;
amp:long_name = "Received signal strength" ;
amp:C_format = "%d" ;
amp:data_min = 17s ;
amp:data_max = 214s ;
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 = -179.8585f ;
heading:data_max = 179.6367f ;
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 = 13.42493f ;
tr_temp:data_max = 15.90391f ;
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 = 31s ;
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 = -6.439125f ;
uship:data_max = 6.694666f ;
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 = -4.8406f ;
vship:data_max = 4.727706f ;

// global attributes:
:featureType = "trajectoryProfile" ;
:history = "Created: 2021-11-17 03:33:59 UTC" ;
:Conventions = "COARDS" ;
:software = "pycurrents" ;
:hg_changeset = "3159:c22d6c40e594" ;
:title = "Shipboard ADCP velocity profiles" ;
:description = "Shipboard ADCP velocity profiles from in2021_e01 using instrument os75nb - Short Version." ;

```
                :cruise_id = "in2021_e01" ;
                :sonar = "os75nb" ;
                :yearbase = 2021 ;
                :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 in2021_e01_os150nb {
dimensions:
        time = 836 ;
        depth_cell = 60 ;
variables:
        int trajectory ;
                trajectory:standard_name = "trajectory_id" ;
        double time(time) ;
                time:long_name = "Decimal day" ;
                time:units = "days since 2021-01-01 00:00:00" ;
                time:C_format = "%12.5f" ;
                time:standard_name = "time" ;
                time:data_min = 313.031678240741 ;
                time:data_max = 317.01650462963 ;
        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 = 147.368366666667 ;
                lon:data_max = 148.716408333333 ;
        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 = -43.5933611111111 ;
                lat:data_max = -42.9338944444444 ;
        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 = 489.97f ;
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 = -0.501792f ;
u:data_max = 0.6896524f ;
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 = -0.5520007f ;
v:data_max = 0.5488235f ;
short amp(time, depth_cell) ;
amp:missing_value = 32767s ;
amp:long_name = "Received signal strength" ;
amp:C_format = "%d" ;
amp:data_min = 20s ;
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 = -179.7487f ;
heading:data_max = 179.9482f ;
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 = 13.3092f ;
                tr_temp:data_max = 15.76752f ;
        short num_pings(time) ;
                num_pings:long_name = "Number of pings averaged per ensemble" ;
                num_pings:units = "None" ;
                num_pings:C_format = "%d" ;
                num_pings:data_min = 16s ;
                num_pings:data_max = 251s ;
        float uship(time) ;
                uship:missing_value = 1.e+38f ;
                uship:long_name = "Ship zonal velocity component" ;
                uship:units = "meter second-1" ;
                uship:C_format = "%9.4f" ;
                uship:data_min = -6.445235f ;
                uship:data_max = 6.692454f ;
        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 = -4.834533f ;
                vship:data_max = 5.415216f ;

// global attributes:
                :featureType = "trajectoryProfile" ;
                :history = "Created: 2021-11-17 03:33:18 UTC" ;
                :Conventions = "COARDS" ;
                :software = "pycurrents" ;
                :hg_changeset = "3159:c22d6c40e594" ;
                :title = "Shipboard ADCP velocity profiles" ;
                :description = "Shipboard ADCP velocity profiles from in2021_e01 using
instrument os150nb - Short Version." ;
                :cruise_id = "in2021_e01" ;
                :sonar = "os150nb" ;
                :yearbase = 2021 ;
                :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",
                "" ;
}
```