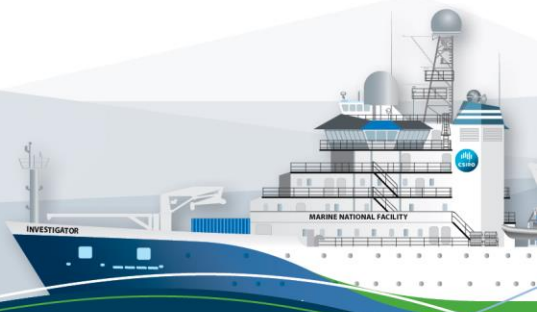
RV *Investigator*

ADCP Processing Report

Voyage:	IN2019_T04
Voyage title:	Singapore Dry Dock Transit
Depart:	Port of Fremantle, 1940 Saturday, 15 June 2019 AWST
Return:	Sembawang Dry Dock, Singapore, 1200 Tuesday, 25 June 2019 SST
Chief Scientist:	Stephanie Zeliadt
Affiliation:	CSIRO
Report compiled by:	Stephanie Zeliadt



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1 Summary

Data was collected during IN2019_T04 for the first half of the voyage until reaching approximately latitude 9S as recording of data was not permitted in Indonesian waters. 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 flush with the hull for the duration of the voyage.

A new data acquisition PC was commissioned and tested during this voyage. See the voyage computing and electronics report for more details regarding data acquisition.

2 Processing Background

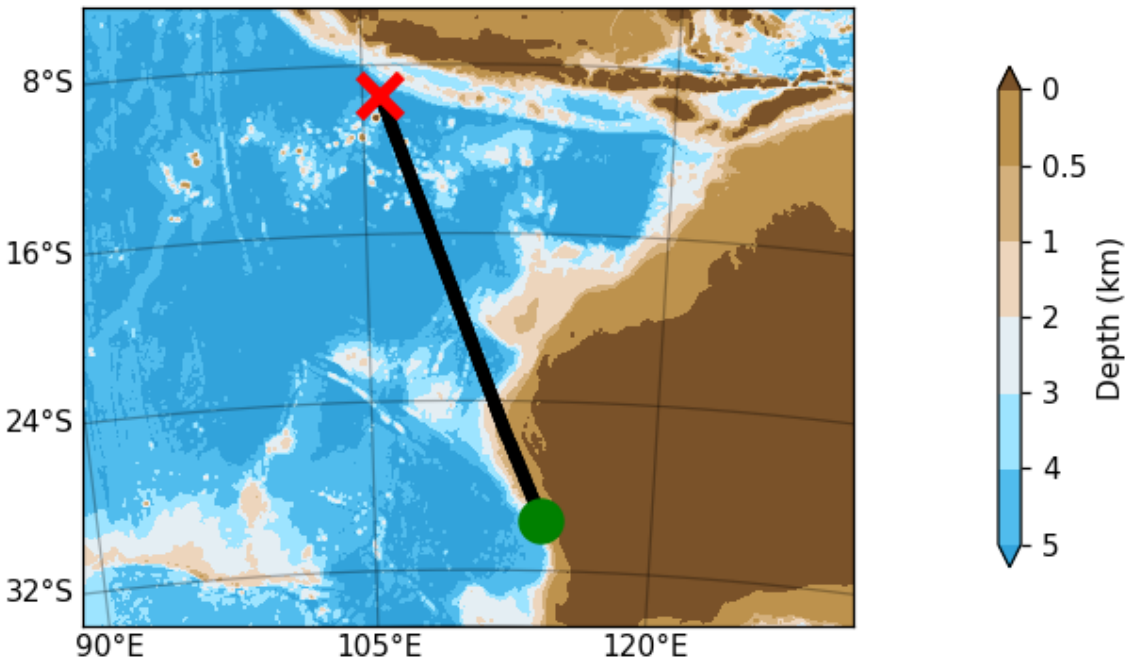
The University of Hawaii's CODAS software 2903:dd2872d4fef0 dated Apr 09 2019 was used for data post-processing.

3 Processing Notes

Issues with the commissioning of the new PC were identified and resolved early in the voyage. Overall data quality was good for the duration of the voyage.

Some profiles were edited out, both manually and using CODAS's automatic processing. The dataset was rotated by 34.5 degrees.

4 Area Covered



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

5 netCDF Data Headers

5.1 in2019_t04_os75nb.nc

```
netcdf in2019_t04_os75nb {
dimensions:
	time = 1238 ;
	depth_cell = 60 ;
variables:
	int trajectory ;
		trajectory:standard_name = "trajectory_id" ;
	double time(time) ;
		time:long_name = "Decimal day" ;
		time:units = "days since 2019-01-01 00:00:00" ;
		time:C_format = "%12.5f" ;
		time:standard_name = "time" ;
		time:data_min = 166.107256944444 ;
		time:data_max = 170.405046296296 ;
	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 = 105.82115 ;
		lon:data_max = 114.0067 ;
	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 = -29.6040444444444 ;
        lat:data_max = -9.40106388888889 ;
float depth(time, depth_cell) ;
        depth:missing_value = 1.e+38f ;
        depth:long_name = "Depth" ;
        depth:units = "meter" ;
        depth:C_format = "%8.2f" ;
        depth:positive = "down" ;
        depth:data_min = 29.93f ;
        depth:data_max = 973.97f ;
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 = -0.7721252f ;
        u:data_max = 0.6329975f ;
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 = -0.8146396f ;
        v:data_max = 0.7693472f ;
short amp(time, depth_cell) ;
        amp:missing_value = 32767s ;
        amp:long_name = "Received signal strength" ;
        amp:C_format = "%d" ;
        amp:data_min = 15s ;
        amp:data_max = 182s ;
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 = -27.12692f ;
        heading:data_max = -0.9116513f ;
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 = 23.33286f ;
        tr_temp:data_max = 28.14312f ;
```

```
       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 = 29s ;
              num_pings:data_max = 141s ;
       float uship(time) ;
              uship:missing_value = 1.e+38f ;
              uship:long_name = "Ship zonal velocity component" ;
              uship:units = "meter second-1" ;
              uship:C_format = "%9.4f" ;
              uship:data_min = -3.069176f ;
              uship:data_max = -0.8539696f ;
       float vship(time) ;
              vship:missing_value = 1.e+38f ;
              vship:long_name = "Ship meridional velocity component" ;
              vship:units = "meter second-1" ;
              vship:C_format = "%9.4f" ;
              vship:data_min = 5.255479f ;
              vship:data_max = 6.732269f ;

// global attributes:
              :featureType = "trajectoryProfile" ;
              :history = "Created: 2019-07-08 02:02:56 UTC" ;
              :Conventions = "COARDS" ;
              :software = "pycurrents" ;
              :hg_changeset = "2903:dd2872d4fef0" ;
              :title = "Shipboard ADCP velocity profiles" ;
              :description = "Shipboard ADCP velocity profiles from in2019_t04
using instrument os75nb" ;
              :cruise_id = "in2019_t04" ;
              :sonar = "os75nb" ;
              :yearbase = 2019 ;
              :ship_name = "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",
                    "" ;
}
```

5.2 in2019_t04_os150nb.nc

```
netcdf in2019_t04_os150nb {
dimensions:
       time = 1238 ;
       depth_cell = 60 ;
variables:
       int trajectory ;
              trajectory:standard_name = "trajectory_id" ;
       double time(time) ;
              time:long_name = "Decimal day" ;
              time:units = "days since 2019-01-01 00:00:00" ;
              time:C_format = "%12.5f" ;
              time:standard_name = "time" ;
              time:data_min = 166.10724537037 ;
              time:data_max = 170.405046296296 ;
       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 = 105.821166666667 ;
              lon:data_max = 114.006772222222 ;
       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 = -29.6041833333333 ;
              lat:data_max = -9.40116388888889 ;
       float depth(time, depth_cell) ;
              depth:missing_value = 1.e+38f ;
              depth:long_name = "Depth" ;
              depth:units = "meter" ;
              depth:C_format = "%8.2f" ;
              depth:positive = "down" ;
              depth:data_min = 17.93f ;
              depth:data_max = 490.f ;
       float u(time, depth_cell) ;
              u:missing_value = 1.e+38f ;
              u:long_name = "Zonal velocity component" ;
              u:units = "meter second-1" ;
```

```
       u:C_format = "%7.2f" ;
       u:data_min = -0.7504215f ;
       u:data_max = 0.6477132f ;
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 = -0.9077373f ;
       v:data_max = 0.841217f ;
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 = 191s ;
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 = -27.1198f ;
       heading:data_max = -0.9200295f ;
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 = 23.0482f ;
       tr_temp:data_max = 27.94504f ;
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 = 61s ;
       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 = -3.068148f ;
       uship:data_max = -0.8472672f ;
float vship(time) ;
       vship:missing_value = 1.e+38f ;
       vship:long_name = "Ship meridional velocity component" ;
       vship:units = "meter second-1" ;
       vship:C_format = "%9.4f" ;
```

```
            vship:data_min = 5.271926f ;
            vship:data_max = 6.705285f ;

// global attributes:
            :featureType = "trajectoryProfile" ;
            :history = "Created: 2019-07-08 02:03:17 UTC" ;
            :Conventions = "COARDS" ;
            :software = "pycurrents" ;
            :hg_changeset = "2903:dd2872d4fef0" ;
            :title = "Shipboard ADCP velocity profiles" ;
            :description = "Shipboard ADCP velocity profiles from in2019_t04
using instrument os150nb" ;
            :cruise_id = "in2019_t04" ;
            :sonar = "os150nb" ;
            :yearbase = 2019 ;
            :ship_name = "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",
                    "" ;
}
```