RV *Investigator*

ADCP Processing Report

Voyage #:	in2019_v01
Voyage title:	The availability of Antarctic krill to large predators and their role in biogeochemical recycling in the Southern Ocean
Depart:	Hobart, 0800 Saturday, 19 January 2019
Return:	Hobart, 0900 Tuesday 5th March, 2019.
Chief Scientist:	Michael Double
Affiliation:	Australian Antarctic Division
Report compiled by:	Peter Shanks

Contents

1 Summary

in2019_v01 used both active and passive acoustics for locating and mapping krill swarms. To minimise interference the ADCP equipment was turned off for most of the voyage. ADCP was active during the transits to and from the area of interest, and for brief periods during CTD casts while in the science area. Data was collected using UHDAS and post-processed using CODAS. The quality of the collected data was generally good.

The University of Hawaii's CODAS software dated 2017.10.01 was used for data post-processing.

2 Processing Notes

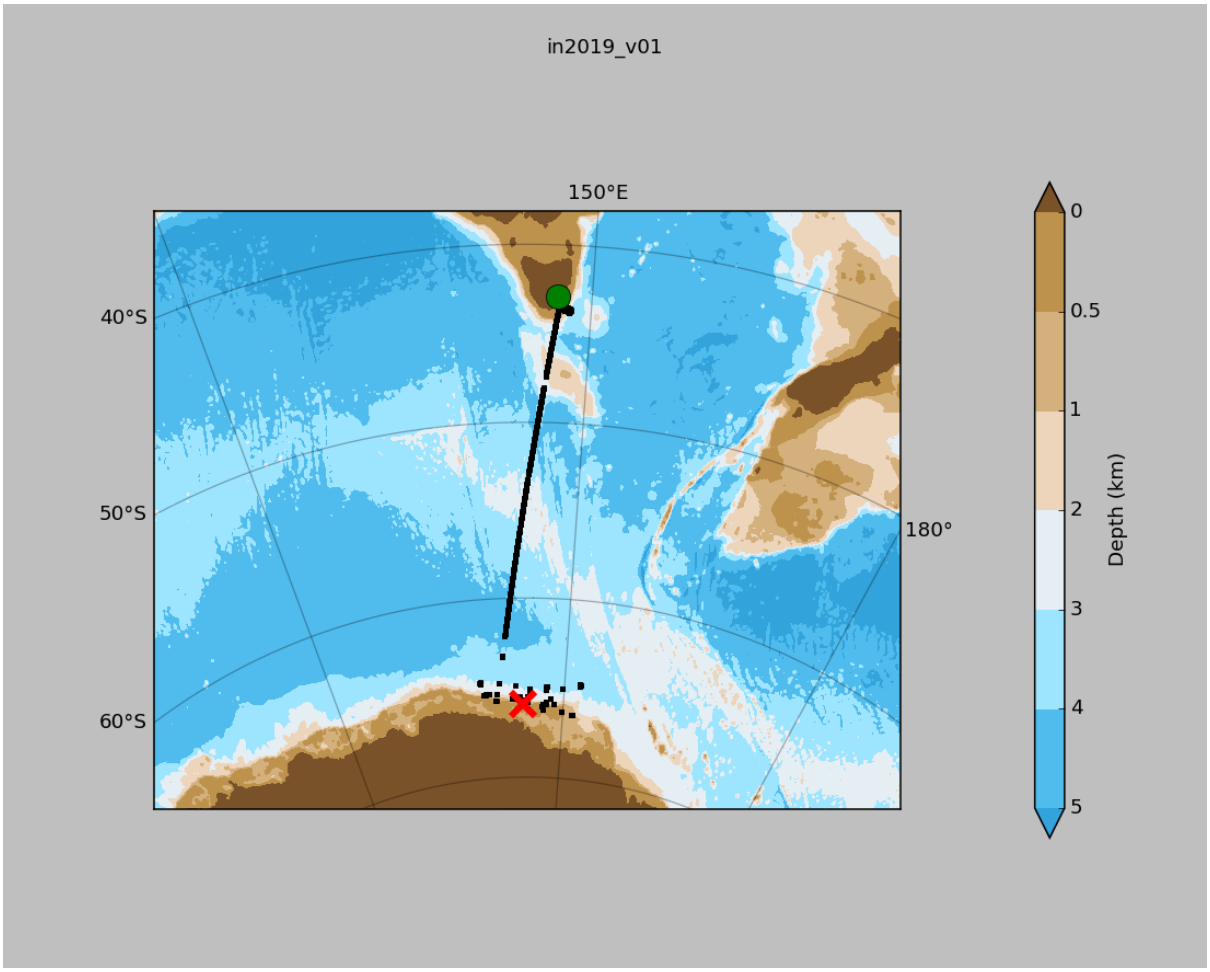
Both the RDI Ocean Surveyor 150kHz ADCP and the RDI Ocean Surveyor 75kHz ADCP were run in narrow band mode.

Internal triggering was used as external triggering was found to be unstable on previous voyages.

The drop keel was 8m below the waterline for the duration of the voyage.

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

3 Area Covered



Please see the webpy_os75nb and webpy_os150nb folders for plots of collected data.

4 netCDF Data Headers

```
netcdf in2019_v01_os75nb {
dimensions:
        time = 2888 ;
        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 = 17.8887384259259 ;
                time:data_max = 62.8520601851852 ;
        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 = 142.326083333333 ;
        lon:data_max = 152.111363888889 ;
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 = -66.4752833333333 ;
        lat:data_max = -42.8867194444444 ;
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 = 974.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 = -1.200138f ;
        u:data_max = 1.096582f ;
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 = -2.178722f ;
        v:data_max = 1.802714f ;
short amp(time, depth_cell) ;
        amp:missing_value = 32767s ;
        amp:long_name = "Received signal strength" ;
        amp:C_format = "%d" ;
        amp:data_min = 8s ;
        amp:data_max = 218s ;
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 = 7b ;
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 = -179.9335f ;
        heading:data_max = 179.9686f ;
```

```
        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 = -0.7425564f ;
                tr_temp:data_max = 20.1396f ;
        byte 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 = -128b ;
                num_pings:data_max = 127b ;
        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 = -4.014013f ;
                uship:data_max = 6.338085f ;
        float vship(time) ;
                vship:missing_value = 1.e+38f ;
                vship:long_name = "Ship meridional velocity component" ;
                vship:units = "meter second-1" ;
                vship:C_format = "%9.4f" ;
                vship:data_min = -6.298552f ;
                vship:data_max = 5.845369f ;

// global attributes:
                :featureType = "trajectoryProfile" ;
                :history = "Created: 2019-04-10 03:41:28 UTC" ;
                :Conventions = "COARDS" ;
                :software = "pycurrents" ;
                :hg_changeset = "2417:49ecfa0cc6c5" ;
                :title = "Shipboard ADCP velocity profiles" ;
                :description = "Shipboard ADCP velocity profiles from in2019_v01 using
instrument os75nb" ;
                :cruise_id = "in2019_v01" ;
                :sonar = "os75nb" ;
                :yearbase = 2019 ;
                :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 in2019_v01_os150nb {
dimensions:
        time = 3802 ;
        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 = 17.8887268518519 ;
        time:data_max = 62.8555324074074 ;
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 = 138.810175 ;
        lon:data_max = 152.111602777778 ;
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 = -66.4753722222222 ;
        lat:data_max = -42.8867055555556 ;
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 = 489.99f ;
float u(time, depth_cell) ;
        u:missing_value = 1.e+38f ;
        u:long_name = "Zonal velocity component" ;
        u:units = "meter second-1" ;
        u:C_format = "%7.2f" ;
        u:data_min = -1.224774f ;
        u:data_max = 2.216331f ;
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 = -1.631161f ;
        v:data_max = 3.096839f ;
short amp(time, depth_cell) ;
        amp:missing_value = 32767s ;
        amp:long_name = "Received signal strength" ;
        amp:C_format = "%d" ;
        amp:data_min = 19s ;
        amp:data_max = 230s ;
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 = 7b ;
        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 = -179.941f ;
                heading:data_max = 179.9524f ;
        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 = -0.779759f ;
                tr_temp:data_max = 19.99636f ;
        byte 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 = -128b ;
                num_pings:data_max = 127b ;
        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 = -4.301834f ;
                uship:data_max = 6.356494f ;
        float vship(time) ;
                vship:missing_value = 1.e+38f ;
                vship:long_name = "Ship meridional velocity component" ;
                vship:units = "meter second-1" ;
                vship:C_format = "%9.4f" ;
                vship:data_min = -6.303169f ;
                vship:data_max = 5.83671f ;

// global attributes:
                :featureType = "trajectoryProfile" ;
                :history = "Created: 2019-04-10 03:54:07 UTC" ;
                :Conventions = "COARDS" ;
                :software = "pycurrents" ;
                :hg_changeset = "2417:49ecfa0cc6c5" ;
                :title = "Shipboard ADCP velocity profiles" ;
                :description = "Shipboard ADCP velocity profiles from in2019_v01 using
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                :cruise_id = "in2019_v01" ;
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                :CODAS_variables = "\n",
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                        "\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",
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================================================================\n",
                        "\n",
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                :CODAS_processing_note = "\n",
                        "CODAS processing note:\n",
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                        "\n",
                        "Overview\n",
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                        "The CODAS database is a specialized storage format designed for\n",
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                        "averaged shipboard ADCP velocities and other variables, during the\n",
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                        "form contains ocean velocities relative to earth, time, position,\n",
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                        "the entire CODAS database.  Some variables are no longer used, and
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                        "late 1980\'s.\n",
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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",
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                "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",
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                "Whenever single-ping data have been recorded, full CODAS
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                "provides the best end product.\n",
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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",
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                "zero-average over a reference layer plus a reference layer
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layer\n",
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                "note (time):\n",
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floating\n",
                "point interval in days since the start of the year, usually the
year\n",
                "of the first day of the cruise.\n",
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                "note (heading):\n",
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                "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",
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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",
                    "" ;
}
```