RV Investigator

ADCP Processing Report

<table>
<thead>
<tr>
<th>Voyage #</th>
<th>IN2017_V03</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voyage title</td>
<td>Sampling the abyss: latitudinal biodiversity patterns along the base of Australia’s eastern continental margin</td>
</tr>
<tr>
<td>Depart</td>
<td>Bell Bay, 2000, 15 May 2017</td>
</tr>
<tr>
<td>Return</td>
<td>Brisbane, 0800 Friday, 16 June 2017</td>
</tr>
<tr>
<td>Voyage Manager</td>
<td>Brett Muir</td>
</tr>
<tr>
<td>Chief Scientist</td>
<td>Dr Tim O’Hara</td>
</tr>
<tr>
<td>Affiliation</td>
<td>Museums Victoria</td>
</tr>
<tr>
<td>Report compiled by</td>
<td>Peter Shanks</td>
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1 Summary

Only the RDI Ocean Surveyor 75kHz ADCP was operational during this voyage. The system was turned off during net/instrument tows to ensure it didn’t interfere with the USBL.

The RDI Ocean Surveyor 150kHz ADCP was not operated due to a hardware fault, so all data was collected with the RDI Ocean Surveyor 75kHz ADCP, which was run in narrow band and broadband modes, depending on the ocean depth.

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

The drop keels were typically used at flush with Gondola (2m). The ship’s officers raised concerns about the keel locking pins getting damaged in rough weather, consequently the keels were retrieved to flush with hull during rough weather transits.

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

2 Processing Background

The University of Hawaii’s CODAS software was used for data post-processing. UHDAS+CODAS 2017.10.01-python software was used.

3 Processing Notes

Although the OS150 was out of service, the majority of the voyage was in deep water, more suitable for the OS75 instrument. A mix of broadband and narrowband data collection was used on the OS75 – these datasets were processed separately, producing the two NetCDF files: in2017_v03_os75bb.nc and in2017_v03_os75nb.nc (both zipped into in2017_v03_os75.zip).

Please see the webpy_os75bb and webpy_os75nb folders for overview plots of collected data.
3.1 Area Covered
4 NetCDF Data Headers

4.1 in2017_v03_os75bb

```plaintext
netcdf in2017_v03_os75bb {

dimensions:
    time = 1200;
    depth_cell = 80;

variables:
    int trajectory;
        trajectory:standard_name = "trajectory_id";

    double time(time);
        time:long_name = "Decimal day";
        time:units = "days since 2017-01-01 00:00:00";
        time:C_format = "%12.5f";
        time:standard_name = "time";
        time:data_min = 135.188761574074;
        time:data_max = 145.964733796296;

    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 = 148.869986111111;
        lon:data_max = 150.918088888889;

    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 = -41.7595694444444 ;
lat: data_max = -36.3025222222222 ;

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 = 22.48f ;
  depth: data_max = 654.52f ;

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 = -1.253971f ;
  u: data_max = 0.6543617f ;

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 = -4.016973f ;
  v: data_max = 1.020983f ;

short amp(time, depth_cell) ;
  amp: missing_value = 32767s ;
  amp: long_name = "Received signal strength" ;
  amp: C_format = "%d" ;
  amp: data_min = 9s ;
  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 = 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 = -179.3782f;
heading:data_max = 179.4737f;

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 = 16.6f;
tr_temp:data_max = 20.37548f;

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 = 13b;
num_pings:data_max = 74b;

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 = -5.43003f;
uship:data_max = 5.101176f;

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 = -5.548585f;
vship:data_max = 5.706337f;

// global attributes:
:featureType = "trajectoryProfile";
:history = "Created: 2018-07-23 05:14:45 UTC";
:Conventions = "COARDS";
:software = "pycurrents";
:hg_changeset = "2417:49ecfa0cc6c5";
:title = "Shipboard ADCP velocity profiles";
:description = "Shipboard ADCP velocity profiles from in2017_v03 using instrument os75bb";
:cruise_id = "in2017_v03";
:sonar = "os75bb";
:yearbase = 2017;
: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"
The CODAS database is a specialized storage format designed for shipboard ADCP data. CODAS processing uses this format to hold averaged shipboard ADCP velocities and other variables, during the stages of data processing. The CODAS database stores velocity profiles relative to the ship as east and north components along with position, ship speed, heading, and other variables. The netCDF *short*
"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\n",
"late 1980\'s.\n",
"\n",
"Post-processing\n",
"--------------\n",
"CODAS post-processing, i.e. that occurs after the single-ping\n",
"profiles have been vector-averaged and loaded into the CODAS\n",
"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\n",
"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.

Pings are grouped into an "ensemble" (usually 2-5 minutes duration) and undergo a suite of automated editing algorithms (removal of acoustic interference; identification of the bottom; editing based on thresholds; and specialized editing that targets CTD wire interference and "weak, biased profiles"). The ensemble of single-ping velocities is then averaged using an iterative reference layer averaging scheme. Each ensemble is approximated as a single function of depth, with a zero-average over a reference layer plus a reference layer velocity for each ping. Adding the average of the single-ping reference layer velocities to the function of depth yields the ensemble-average velocity profile. These averaged profiles, along with ancillary measurements, are written to disk, and subsequently loaded into the CODAS database. Everything after this stage is post-processing.

Time is stored in the database using UTC Year, Month, Day, Hour, Minute, Seconds. Floating point time "Decimal Day" is the floating point interval in days since the start of the year, usually the year of the first day of the cruise.

CODAS processing uses heading from a reliable device, and (if available) uses a time-dependent correction by an accurate heading device. The reliable heading device is typically a gyro compass (for example, the Bridge gyro). Accurate heading devices can be POSMV, Seapath, Phins, Hydrins, MAHRS, or various Ashtech devices; this
"varies with the technology of the time. It is always confusing to
"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", 
"\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",
"\n
4.2 in2017_v03_os75nb

netcdf in2017_v03_os75nb {
  dimensions:
    time = 3331 ;
    depth_cell = 60 ;
  variables:
    int trajectory ;
      trajectory:standard_name = "trajectory_id" ;
    double time(time) ;
}
time:long_name = "Decimal day";
time:units = "days since 2017-01-01 00:00:00";
time:C_format = "%12.5f";
time:standard_name = "time";
time:data_min = 134.457175925926;
time:data_max = 165.957650462963;
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 = 146.744166666667;
lon:data_max = 154.736972222222;
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 = -41.7595694444444;
lat:data_max = -23.62735;
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 = -2.09484f;
u:data_max = 1.074216f;
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 = -2.965518f;
v:data_max = 0.9042082f;

short amp(time, depth_cell);
amp:missing_value = 32767s;
amp:long_name = "Received signal strength";
amp:C_format = "%d";
amp:data_min = 6s;
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 = -179.954f;
heading:data_max = 179.9206f;

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 = 15.22813f;
tr_temp:data_max = 24.93546f;

byte num_pings(time);
num_pings:long_name = "Number of pings averaged per ensemble";
num_pings:units = "None";
num_pings:C_format = "%d" ;
um_pings:data_min = -124b ;
um_pings:data_max = 118b ;

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 = -5.440792f ;
uship:data_max = 6.326447f ;

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 = -6.117421f ;
vship:data_max = 6.284678f ;

// global attributes:
:FeatureType = "trajectoryProfile" ;
:history = "Created: 2018\-07\-24 06:11:45 UTC" ;
:Conventions = "COARDS" ;
:software = "pycurrents" ;
:hg_changeset = "2417:49ecfa0cc6c5" ;
:title = "Shipboard ADCP velocity profiles" ;
:description = "Shipboard ADCP velocity profiles from in2017\_v03 using instrument os75nb" ;
:cruise_id = "in2017\_v03" ;
:sonar = "os75nb" ;
:yearbase = 2017 ;
: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",
  "************

=================================================================
"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",
"------------

CODAS processing note: \n",
"-----------

The CODAS database is a specialized storage format designed for shipboard ADCP data. "CODAS processing" uses this format to hold averaged shipboard ADCP velocities and other variables, during the stages of data processing. The CODAS database stores velocity profiles relative to the ship as east and north components along with position, ship speed, heading, and other variables. The netCDF *short* form contains ocean velocities relative to earth, time, position, transducer temperature, and ship heading; these are designed to be ready for immediate use. The netCDF *long* form is just a dump of the entire CODAS database. Some variables are no longer used, and all have names derived from their original CODAS names, dating back to the late 1980's.

Post-processing
",
"-------------

CODAS post-processing, i.e. that which occurs after the single-profile vector-averaged and loaded into the CODAS database,
includes editing (using automated algorithms and manual tools),
rotation and scaling of the measured velocities, and application of a

time-varying heading correction. Additional algorithms developed more
recently include translation of the GPS positions to the transducer
location, and averaging of ship's speed over the times of valid pings
when Percent Good is reduced. Such post-processing is needed prior to
submission of "processed ADCP data" to JASADCP or other archives.

Full CODAS processing
---------------------
Whenever single-ping data have been recorded, full CODAS processing
provides the best end product.

Full CODAS processing starts with the single-ping velocities in beam
coordinates. Based on the transducer orientation relative to the
hull, the beam velocities are transformed to horizontal, vertical, and
error velocity components. Using a reliable heading (typically from
the ship's gyro compass), the velocities in ship coordinates are
rotated into earth coordinates.
Pings are grouped into an "ensemble" (usually 2-5 minutes duration)
and undergo a suite of automated editing algorithms (removal of
acoustic interference; identification of the bottom; editing based on
thresholds; and specialized editing that targets CTD wire interference
and "weak, biased profiles"). The ensemble of single-ping velocities
is then averaged using an iterative reference layer averaging scheme.
Each ensemble is approximated as a single function of depth, with a
zero-average over a reference layer plus a reference layer velocity
for each ping. Adding the average of the single-ping reference layer
velocities to the function of depth yields the ensemble-average
velocity profile. These averaged profiles, along with ancillary
measurements, are written to disk, and subsequently loaded into the
CODAS database. Everything after this stage is "post-processing".

note (time):
------------
Time is stored in the database using UTC Year, Month, Day, Hour,
Minute, Seconds. Floating point time "Decimal Day" is the floating
point interval in days since the start of the year, usually the year
"of the first day of the cruise.\n",
"\n",
"note (heading):\n",
"-------------\n",
"CODAS processing uses heading from a reliable device, and (if available) uses a time-dependent correction by an accurate heading device. The reliable heading device is typically a gyro compass (for example, the Bridge gyro). Accurate heading devices can be POSMV, Seapath, Phins, Hydrins, MAHRS, or various Ashtech devices; this varies with the technology of the time. It is always confusing to keep track of the sign of the heading correction. Headings are written in 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 amounts to (u+i*v)*(exp(i*theta)) where theta is the sum of the corrected heading and the transducer angle.\n",
"\n",
"theta = X + (G - dh) = X + G - dh\n",
"\n",
"Watertrack and Bottomtrack calibrations give an indication of the residual angle offset to apply, for example if mean and median of the phase are all 0.5 (then R=0.5). Using the "rotate" command, 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",
"\n";