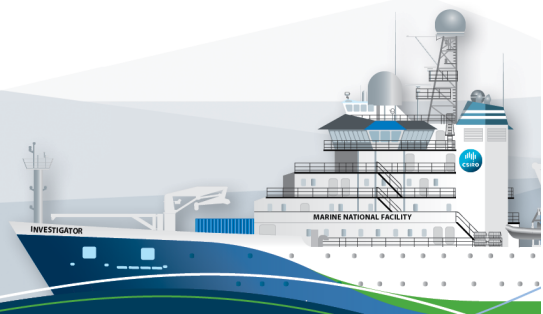
RV *Investigator*

ADCP Processing Report

Voyage #:	in2016_t01
Voyage title:	Continuity of Australian terranes into Zealandia: towards a geological map of the east Gondwana margin.
Depart:	Lautoka, Fiji, 1830, Thursday, 30 June 2016
Return:	Hobart, 0700, Thursday, 14 July 2016
Chief Scientist:	Simon Williams
Affiliation:	University of Sydney
Report compiled by:	Hugh Barker



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Contents

1 Summary 3
2 Processing Background 3
3 Processing Notes 3
4 Data Header 3

1 Summary

Data was collected during in2016_t01 for the duration of the voyage. Data was collected using VMDAS and post-processed using CODAS.

See the voyage computing and electronics report for more details regarding data acquisition. Drop keels were both deployed at mid extension, approx. 8.5m below the waterline.

Data coverage was generally good, however there are some gaps due to missing navigation data and in shallow waters around the Pacific. Bad data has been edited out.

2 Processing Background

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

3 Processing Notes

See summary.

4 netCDF Data Headers

```
netcdf in2016_t01_os75nb {
dimensions:
        time = 3590 ;
        depth_cell = 50 ;
variables:
        int trajectory ;
                trajectory:standard_name = "trajectory_id" ;
        double time(time) ;
                time:long_name = "Decimal day" ;
                time:units = "days since 2016-01-01 00:00:00" ;
                time:C_format = "%12.5f" ;
                time:standard_name = "time" ;
                time:data_min = 181.382465277778 ;
                time:data_max = 194.316481481481 ;
        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 = 147.407227777778 ;
                lon:data_max = 177.194063888889 ;
        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 = -43.2934472222222 ;
                lat:data_max = -17.93365 ;
        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 = 32.43f ;
                depth:data_max = 816.5f ;
        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 = -5.021224f ;
                u:data_max = 1.188111f ;
        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 = -0.7183723f ;
                v:data_max = 1.391875f ;
        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 = 217s ;
        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 = -179.9859f ;
                heading:data_max = 179.957f ;
        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 = 12.96853f ;
                tr_temp:data_max = 27.90831f ;
        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 = 10b ;
                num_pings:data_max = 125b ;
        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 = -6.794491f ;
                uship:data_max = 5.638309f ;
        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 = -6.512738f ;
                vship:data_max = 6.283752f ;

// global attributes:
                :featureType = "trajectoryProfile" ;
                :history = "Created: 2018-09-12 05:36:22 UTC" ;
                :Conventions = "COARDS" ;
```

```
                :software = "pycurrents" ;
                :hg_changeset = "2471:ee56db9c23c2" ;
                :title = "Shipboard ADCP velocity profiles" ;
                :description = "Shipboard ADCP velocity profiles from in2016_t01 using instrument
os75nb" ;
                :cruise_id = "in2016_t01" ;
                :sonar = "os75nb" ;
                :yearbase = 2016 ;
                :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 in2016_t01_os150nb {
dimensions:
        time = 3604 ;
        depth_cell = 50 ;
variables:
        int trajectory ;
                trajectory:standard_name = "trajectory_id" ;
        double time(time) ;
                time:long_name = "Decimal day" ;
                time:units = "days since 2016-01-01 00:00:00" ;
                time:C_format = "%12.5f" ;
                time:standard_name = "time" ;
                time:data_min = 181.383194444444 ;
                time:data_max = 194.31755787037 ;
        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 = 147.402113888889 ;
                lon:data_max = 177.190563888889 ;
        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 = -43.2935916666667 ;
                lat:data_max = -17.9345305555556 ;
        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 = 24.43f ;
                depth:data_max = 416.49f ;
        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 = -1.18016f ;
                u:data_max = 1.272967f ;
        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 = -0.9191905f ;
                v:data_max = 0.7146468f ;
        short amp(time, depth_cell) ;
                amp:missing_value = 32767s ;
                amp:long_name = "Received signal strength" ;
                amp:C_format = "%d" ;
                amp:data_min = 18s ;
                amp:data_max = 222s ;
        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 = -179.9694f ;
                heading:data_max = 179.9579f ;
        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 = 12.64777f ;
                tr_temp:data_max = 27.24194f ;
        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 = -6.796193f ;
                uship:data_max = 5.659688f ;
        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 = -6.504538f ;
                vship:data_max = 6.283875f ;

// global attributes:
                :featureType = "trajectoryProfile" ;
                :history = "Created: 2018-09-12 05:33:53 UTC" ;
                :Conventions = "COARDS" ;
                :software = "pycurrents" ;
                :hg_changeset = "2471:ee56db9c23c2" ;
                :title = "Shipboard ADCP velocity profiles" ;
                :description = "Shipboard ADCP velocity profiles from in2016_t01 using instrument
os150nb" ;
                :cruise_id = "in2016_t01" ;
                :sonar = "os150nb" ;
```

```
                :yearbase = 2016 ;
                :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",
                "" ;
}
```