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**NAME**

**mbackangle** – Generates tables of the average amplitude or sidescan values in swath sonar data as a function of the grazing angle with the seafloor.

**VERSION**

Version 5.0

**SYNOPSIS**

**mbackangle** [-Akind -C -D -Fformat -Gkind/angle/min/max/nx/ny -Ifile -Nnangle/anglemax -Ppings -Q -Rrefangle -Ttopogridfile -Zaltitude -V -H]

**DESCRIPTION**

The program **mbackangle** reads a swath sonar data file containing beam amplitude and/or sidescan data and generates tables of the average amplitude and/or sidescan values as a function of the grazing angle with the seafloor. These tables can be used by the program **mbprocess** to correct the sidescan or amplitude data for the variation with grazing angle. No assumption is made about the nature of the data or the sonar used to collect it.

The user specifies the angular width of the swath considered and the number of angular bins in that swath; the average amplitude or sidescan value within each bin form the output data. By default, the grazing angle is calculated simply using the acrosstrack distance and depth at the beam or pixel location. If bathymetry is not available, the seafloor is assumed to be flat with a sonar altitude specified by the **-Z** option. If the **-Q** option is used, then the acrosstrack bottom slope at the beam or pixel location is factored into the grazing angle values. For bins outside the nadir region (angles > 15.0 degrees from vertical), the averaging extends over the neighboring bins (three bins averaged for each value). The user also specifies the number of pings to be read to generate each table; the default is 50 pings.

The results are written to a file named by adding a ".sga" suffix to the swath filename for sidescan and ".aga" for amplitude. These files contain a series of amplitude vs. grazing angle tables, each time tagged according to the average time of the pings used to generate that table. The swath file's **mbprocess** parameter file is also modified (or created if necessary) so that sidescan or amplitude correction is enabled.

The correction tables are read and interpolated according to ping time by **mbprocess**. The correction value for each amplitude or sidescan sample is also interpolated using the samples apparent grazing angle. The grazing angle is calculated using a flat bottom assumption by default but, if the **-Q** option is used, will instead be calculated using the acrosstrack slope in the bathymetry (if available). If the **-T** option is used to specify a topography grid of the area of interest, then the grazing angle is calculated using that grid rather than any bathymetry data within the file being processed.

If the values are in dB, and therefore log scaled, then the corrections are subtracted from the raw values and then the value of the correction table at the reference angle (specified with the **-R** option) is added back in. In the case of linear data, the correction operation is to divide by the correction value and then multiply by the reference value. Most amplitude and sidescan data supported by **MB-System** are in dB.

If the **-G** option is used, then **mbackangle** also generates gridded histograms of the amplitude versus grazing angle values for each swath data file processed. The user specifies the bounds and dimensions of the grids; the **-G** option must be given twice to produce grids of both amplitude and sidescan histograms. In addition to outputting the grids, **mbackangle** uses **mbm\_grdplot** to generate **GMT** shellscripts that, when executed, will generate plots of the gridded histograms overlain with the amplitude versus grazing angle tables in the ".aga" and ".sga" files.

## MB-SYSTEM AUTHORSHIP

David W. Caress  
 Monterey Bay Aquarium Research Institute  
 Dale N. Chayes  
 Center for Coastal and Ocean Mapping  
 University of New Hampshire  
 Christian do Santos Ferreira  
 MARUM - Center for Marine Environmental Sciences  
 University of Bremen

## OPTIONS

- A** *kind*  
 Determines if beam amplitude (*kind* = 1) and/or sidescan (*kind* = 2) data will be processed. Default: both amplitude and sidescan data are processed.
- C** Normally, **mbackangle** produces a table of amplitude vs grazing angle values which is asymmetric about the vertical (zero angle) axis. If **-C** is specified, the amplitude vs grazing angle function will be forced to be symmetric. Generally, it is better to not use this option in **mbackangle**, and to instead use **mbset** to set symmetric or asymmetric sidescan correction in the **mbprocess** parameter file.
- D** This option causes **mbackangle** to dump the output to stdout rather than to ".sga" or ".aga" files..
- F** *format*  
 Sets the **MBIO** integer format identifier for the input file specified with the **-I** option. By default, **mbackangle** infers the format from the "\*.mbXX" **MB-System** suffix convention.
- G** *kind/angle/min/max/nx/ny*  
 This option causes **mbackangle** to output gridded histograms of the amplitude versus grazing angle data for each swath file processed. The program also generates a shellscript to produce a first-cut **GMT** postscript plot of the histogram overlain by the amplitude versus grazing angle tables used by **mbprocess**. The *kind* parameter indicates whether an amplitude (*kind* = 1) or sidescan (*kind* = 2) histogram is desired; the **-G** command must be given twice (once with *kind* = 1 and once with *kind* = 2) to generate both amplitude and sidescan histograms. The histogram grid consists of *nx* bins extending from *-angle* to *+angle* degrees in the x-dimension, and *ny* bins of backscatter value extending from *min* to *max* in the y-dimension. The values of the histogram are normalized so that they sum to 1000.0 within each angle bin.
- H** This "help" flag causes the program to print out a description of its operation and then exit immediately.
- I** *filename*  
 Sets the input filename. If *format* > 0 (set with the **-F** option) then the swath sonar data contained in *infile* is read and processed. If *format* < 0, then *infile* is assumed to be an ascii file containing a list of the input swath sonar data files to be processed and their formats. The program will read and process the data in each one of these files. Each input file will have an associated output file with either the ".sga" or ".aga" suffix. In the *infile* file, each data file should be followed by a data format identifier, e.g.:  
     datafile1 11  
     datafile2 24  
 This program uses the **MBIO** library and will read any swath sonar format supported by **MBIO**. A list of the swath sonar data formats currently supported by **MBIO** and their identifier values is given in the **MBIO** manual page. Default: *infile* = "datalist.mb-1".
- N** *nangle/angle*  
 The amplitude vs grazing angle table is calculated by binning the amplitude values according to their grazing angles and averaging the amplitudes within each bin. This option sets the number of grazing angle bins (*nangle*) and the maximum angle considered (*angle*). The grazing angle

function will be defined at *nangle* points spaced equally from *-angle* to *+angle*. The *nangle* value should be an odd integer so that the middle bin is centered on the angle 0.0. Default: *nangle* = 81, *angle* = 80.0.

- P** *pings*  
Sets the number of pings to be read and averaged for each amplitude vs grazing angle table. The output "\*.sga" or ".aga" files will generally contain many tables, each with a timestamp corresponding to the average of the ping times used for each table. A table may be output averaged over a lesser number of beams if a time gap is encountered in the data, and also at the end of the file. Default: *pings* = 50.
- Q**  
By default, **mbbackangle** does not use seafloor slopes in calculating the grazing angles for each amplitude beam and sidescan pixel. This option causes the program to calculate across-track slopes from swath bathymetry, if available, and to factor these slopes into the grazing angle calculation for each data point.
- R** *refangle*  
Sets the reference angle that will be used by **mbprocess** in applying the amplitude and/or sidescan correction tables generated by **mbbackangle**. Default: *refangle* = 30.0 degrees.
- T** *topogridfile*  
By default, **mbbackangle** does not use seafloor slopes in calculating the grazing angles for each amplitude beam and sidescan pixel. This option causes the program to calculate across-track slopes using the topography grid *topogridfile*, and to factor these slopes into the grazing angle calculation for each data point.
- V**  
Normally, **mbbackangle** works "silently" without outputting anything to the stderr stream. If the **-V** flag is given, then **mbmask** works in a "verbose" mode and outputs the program version being used and all error status messages.
- Z** *depth*  
This option specifies a default sonar altitude value in meters to be used whenever bathymetry values are unavailable. A flat seafloor (zero slope) will be assumed wherever the default depth needs to be used (e.g. data files with sidescan but no bathymetry, or the outer parts of swaths where the sidescan may extend further than the bathymetry). If this option is not specified, any amplitude or sidescan values without associated bathymetry information will not be used in calculating the amplitude vs grazing angle table.

## EXAMPLE

Suppose one has a Simrad EM300 data file called 0003\_20020425\_022926.mb57 which contains 131 pings. In order to correct the beam amplitude and sidescan with **mbprocess**, first use **mbbackangle** to generate the amplitude vs grazing angle tables:

```
mbbackangle -I mbari_1998_988_msn.mb57 \
-N81/80.0 -P50 \
-G1/80/60/81/121 \
-G2/80/60/81/121 \
-V
```

Here the angle bins will be 2.0 degree wide, the table will extend from -80.0 degrees (port) to +80.0 (starboard), and each table will represent the averages over up to 50 pings. The output looks like:

```
Program mbackangle
MB-system Version 5.0.4
```

```
Pings to average: 50
Number of angle bins: 81
Maximum angle: 80.000000
Default altitude: 0.000000
Working on beam amplitude data...
Working on sidescan data...
Using flat bottom assumption in calculating correction tables...
```

Outputting gridded histograms of beam amplitude vs grazing angle...  
 Outputting gridded histograms of sidescan amplitude vs grazing angle...

processing swath file: mbari\_1998\_988\_msn.mb57 57

7274 records processed  
 805564 amplitude data processed  
 146 tables written to mbari\_1998\_988\_msn.mb57.ag  
 5371412 sidescan data processed  
 146 tables written to mbari\_1998\_988\_msn.mb57.sga

Plot generation shellscript <mbari\_1998\_988\_msn.mb57\_aga.grd.cmd> created.  
 Plot generation shellscript <mbari\_1998\_988\_msn.mb57\_sga.grd.cmd> created.

7274 total records processed  
 805564 total amplitude data processed  
 146 total aga tables written  
 5371412 total sidescan data processed  
 146 total sga tables written

The output files include the amplitude versus grazing angle tables in mbari\_1998\_988\_msn.mb57.ag and mbari\_1998\_988\_msn.mb57.sga, the gridded histogram files mbari\_1998\_988\_msn.mb57\_aga.grd and mbari\_1998\_988\_msn.mb57\_sga.grd, and the plotting shellscripts mbari\_1998\_988\_msn.mb57\_aga.grd.cmd and mbari\_1998\_988\_msn.mb57\_sga.grd.cmd. The **mbprocess** parameter file mbari\_1998\_988\_msn.mb57.par has also been either created (if necessary) or modified to enable sidescan correction using the ".sga" tables. The first of the six tables in mbari\_1998\_988\_msn.mb57.sga looks like:

```
## Sidescan correction table files generated by program mbackangle
## MB-system Version 5.0.4
## Table file format: 1.0.0
## Run by user <caress> on cpu <hess> at <Fri Oct 1 11:18:30 2004>
## Input swath file: mbari_1998_988_msn.mb57
## Input swath format: 57
## Output table file: mbari_1998_988_msn.mb57.sga
## Pings to average: 50
## Number of angle bins: 81
## Maximum angle: 80.000000
## Default altitude: 0.000000
## Data type: sidescan
# table: 0
# nping: 50
# time: 1998/06/10 14:55:24.979779 897490524.979780
# nangles: 81
-80.0000 0.0000 0.0000
-78.0000 0.0000 0.0000
-76.0000 0.0000 0.0000
-74.0000 0.0000 0.0000
-72.0000 0.0000 0.0000
-70.0000 0.0000 0.0000
-68.0000 0.0000 0.0000
-66.0000 0.0000 0.0000
-64.0000 33.4828 7.5915
-62.0000 32.4068 5.4016
-60.0000 31.9667 5.3320
```

|          |         |        |
|----------|---------|--------|
| -58.0000 | 31.7880 | 5.1880 |
| -56.0000 | 31.6249 | 5.0681 |
| -54.0000 | 31.6362 | 4.9521 |
| -52.0000 | 31.5590 | 5.0482 |
| -50.0000 | 31.3955 | 5.1242 |
| -48.0000 | 31.0372 | 5.2364 |
| -46.0000 | 30.9569 | 5.1092 |
| -44.0000 | 30.8126 | 4.9848 |
| -42.0000 | 30.3497 | 4.9611 |
| -40.0000 | 29.7660 | 4.9479 |
| -38.0000 | 29.2746 | 4.9727 |
| -36.0000 | 29.1929 | 4.9734 |
| -34.0000 | 29.1729 | 4.9893 |
| -32.0000 | 28.7375 | 5.0295 |
| -30.0000 | 28.6560 | 5.0031 |
| -28.0000 | 28.0609 | 5.1757 |
| -26.0000 | 27.3652 | 5.2692 |
| -24.0000 | 26.2536 | 5.1193 |
| -22.0000 | 25.2113 | 4.8437 |
| -20.0000 | 24.9033 | 4.5717 |
| -18.0000 | 24.4118 | 4.5952 |
| -16.0000 | 24.4341 | 4.5824 |
| -14.0000 | 24.3251 | 4.7864 |
| -12.0000 | 23.6965 | 4.1409 |
| -10.0000 | 24.1326 | 3.7653 |
| -8.0000  | 26.1912 | 4.2246 |
| -6.0000  | 27.9516 | 4.5724 |
| -4.0000  | 31.1992 | 5.6401 |
| -2.0000  | 29.2624 | 5.8076 |
| 0.0000   | 27.4466 | 4.3310 |
| 2.0000   | 24.9780 | 4.1345 |
| 4.0000   | 24.2328 | 4.0980 |
| 6.0000   | 23.3917 | 4.6856 |
| 8.0000   | 24.0867 | 4.5882 |
| 10.0000  | 23.2293 | 4.6383 |
| 12.0000  | 24.1375 | 4.5005 |
| 14.0000  | 25.1402 | 4.6843 |
| 16.0000  | 25.1948 | 4.9131 |
| 18.0000  | 25.0986 | 5.0503 |
| 20.0000  | 25.0798 | 5.0769 |
| 22.0000  | 25.0582 | 5.1801 |
| 24.0000  | 25.6108 | 5.1108 |
| 26.0000  | 25.8393 | 5.0068 |
| 28.0000  | 26.3232 | 4.9469 |
| 30.0000  | 26.4346 | 5.0686 |
| 32.0000  | 26.6474 | 5.1690 |
| 34.0000  | 27.0092 | 5.2098 |
| 36.0000  | 27.1987 | 5.1664 |
| 38.0000  | 27.3710 | 5.2504 |
| 40.0000  | 27.1160 | 5.1788 |
| 42.0000  | 27.0691 | 5.1418 |
| 44.0000  | 27.2547 | 4.8907 |
| 46.0000  | 27.7406 | 4.9654 |
| 48.0000  | 28.1568 | 4.9277 |

|         |         |        |
|---------|---------|--------|
| 50.0000 | 28.4015 | 4.9687 |
| 52.0000 | 28.4042 | 4.9034 |
| 54.0000 | 28.3741 | 4.9500 |
| 56.0000 | 28.5195 | 4.9799 |
| 58.0000 | 28.6455 | 5.0142 |
| 60.0000 | 28.9284 | 4.9876 |
| 62.0000 | 28.9028 | 5.0380 |
| 64.0000 | 0.0000  | 0.0000 |
| 66.0000 | 0.0000  | 0.0000 |
| 68.0000 | 0.0000  | 0.0000 |
| 70.0000 | 0.0000  | 0.0000 |
| 72.0000 | 0.0000  | 0.0000 |
| 74.0000 | 0.0000  | 0.0000 |
| 76.0000 | 0.0000  | 0.0000 |
| 78.0000 | 0.0000  | 0.0000 |
| 80.0000 | 0.0000  | 0.0000 |
| #       |         |        |
| #       |         |        |

## SEE ALSO

**mbsystem(1), mbprocess(1), mbset(1), mbfilter(1)**

## BUGS

None worth bragging about.