NAME

mbclean – Tool to automatically flag bad beams in swath sonar bathymetry data.

VERSION

Version 5.0

SYNOPSIS

mbclean [**–A***max* **–B***low/high* **–C***slope/units* **–D***min/max* **–F***format* **–G***fraction_low/fraction_high* **–I***infile* **–L***lonflip* **–O***outfile* **–M***mode* **–Q***backup* **–R***maxheadingrate* **–S***slope/mode/units* **–T***tolerance* **–U***nmin* **–X***beamsleft/beamsright* **–Y***distanceleft/distanceright* **–V –H]**

DESCRIPTION

mbclean identifies and flags artifacts in swath sonar bathymetry data. Several algorithms are available for identifying artifacts; multiple algorithms can be applied in a single pass. The most commonly used approach is to identify artifacts based on excessive bathymetric slopes. Spikes where an excessive slope occurs before and reverses after a beam can also be removed. If desired, **mbclean** will also flag beams associated with "rails" where outer beams have smaller acrosstrack distances than more inner beams (**–Q** option). Low and high bounds on acceptable depth values can be set; depth values outside the acceptable range will be flagged. The acceptable depth ranges can either be absolute (**–B** option), relative to the local median depth (**–A** option) or defined by low and high fractions of the local median depth (**–G** option). A set number of outer beams can also be flagged.

The order in which the flagging algorithms are applied is as follows:

1. Flag specified numbers of outer beams (**–X** option).
2. Flag outer beams by acrosstrack distance (**–Y** option).
3. Flag soundings outside specified acceptable depth range (**–B** option).
4. Flag pings with excessive heading change rate (**–R** option).
5. Zap "rails" (**–Q** option).
6. Flag soundings outside acceptable depth range using fractions of local median depth (**–G** option).
7. Flag soundings outside acceptable depth range using deviation from local median depth (**–A** option).
8. Flag soundings associated with spikes (**–S** option).
9. Flag soundings associated with excessive slopes (**–C** option or default).
10. Flag all soundings in pings with too few good soundings (**–U** option).

This program flags beams by outputting the flags as edit events to an "edit save file", like that produced by **mbedit**. If an "edit save file" (named by adding a ".esf" suffix to the input swath filename) already exists, the edits are read in and applied before the **mbclean** flagging algorithms are used. Once generated, the edit events can be applied to the data using the program **mbprocess**, which outputs a processed swath data file. The **mbprocess** program is also used to merge edited navigation, recalculate bathymetry, and apply other corrections to swath bathymetry data.

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OPTIONS

–A *max*
This option sets the range of acceptable depth values relative to the local median depth. The median depth is obtained from the current ping and the pings immediately before and after that ping. If a depth value deviates from the median depth by more than *max*, then it will be flagged. No deviation from the median depth checking is done if the **–A** option is not used.

–B *low/high*
This option sets the range of acceptable depth values. If a depth value is less than *low* or more than *high* then it will be flagged. No depth range checking is done if the **–B** option is not used.

–C *slope/unit*
The value *slope* is the maximum acceptable slope. Beams associated with excessive slopes will be flagged or removed according to the operational mode specified using the **–M** option. This method will be used if no other algorithms are specified; if other algorithms are specified but **–C** is not used then no slope checking will occur. *unit* is optional and specifies the unit of *slope*, 0 (default) indicates the slope is in tangents, 1 slope is in radians, 2 slope is in degrees. Default: *slope* = 1.0

–D *min/max*
Sets the minimum and maximum allowed distances between beams used for some of the flagging algorithms. Both values are expressed in terms of fractions of the local median depth. Thus, **–D***0.01/0.25* will translate, if the local median depth is 1000 meters, to a minimum distance of 10 meters and a maximum distance of 250 meters. The *min* value sets the minimum distance between beams required for an excessive slope to be used to flag bad beams. The navigation and heading of the ship are used to calculate the locations of beams. Ship turns often cause beams of adjacent pings to overlap, causing the distances between these beams to become quite small. This can, in turn, magnify noise in the bathymetry data to produce slope estimates which are excessively large. The *max* value sets the maximum distance between the current beam and other beams for those beams to be used in evaluating the current beam. For instance, only beams within the maximum distance are used to calculate the local median depth, and only beams within the maximum distance are used to check for excessive slopes. Default: *min/max* = 0.01/0.25.

–F *format*
Sets the data format used if the input is read from stdin or from a file. If *format* < 0, then the input file specified with the **–I** option will actually contain a list of input swath sonar data files. This program uses the **MBIO** library and will read or write 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: *format* = 11.

–G *fraction_low/fraction_high*
This option sets the range of acceptable depth values relative to low and high fractions of the local median depth. The median depth is obtained from the current ping and the pings immediately before and after that ping. If a depth value is less than *fraction_low* times the median depth (e.g. *fraction_low* = 0.5 means one half the median depth) or more than *fraction_high* times the median depth then it will be flagged. No fractional depth range checking is done if the **–G** option is not used.

–H This "help" flag cause the program to print out a description of its operation and then exit immediately.

–I *infile*
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 or write 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".

−L *lonflip*
Sets the range of the longitude values used. If *lonflip*=−1 then the longitude values will be in the range from −360 to 0 degrees. If *lonflip*=0 then the longitude values will be in the range from −180 to 180 degrees. If *lonflip*=1 then the longitude values will be in the range from 0 to 360 degrees. Default: *lonflip* = 0.

−M *mode*
Sets the manner in which bad beams identified by excessive slope are handled.

mode = 1: Flags one beam associated with each outlier slope. The flagged beam is the one furthest from the local median depth.
mode = 2: Flags both beams associated with each outlier slope.
mode = 3: Zeros one beam associated with each outlier slope. The zeroed beam is the one furthest from the local median depth.
mode = 4: Zeros both beams associated with each outlier slope. If the data format of the input file prohibits storage of negative depths, an error message will be output and the program will exit. Default: *mode* = 1.

−Q *backup*
This flag causes **mbclean** to search for bad "rails" in the swath sonar swath; the "rails" refer to groups of outer beams which have crosstrack distances (and depths) much less than they should have. These are identified when one or more outer beams lies more than *backup* meters inboard of a more inner beam; all beams meeting this criteria are flagged.

−R *maxheadingrate*
The value *maxheadingrate* is the maximum acceptable rate of change in heading in degrees/second. All soundings associated with pings for which the heading was changing at a greater rate will be flagged.

−S *slope/mode/unit*
The value *slope* is the maximum acceptable spike slope. If the slope from the preceding beam to this beam exceeds this value, and the slope from this beam to subsequent beam exceeds this value but with an opposite sign this beam is considered a spike and will be flagged or removed according to the operational mode specified using the **−M** option. Acrosstrack slopes are determined by the preceding and subsequent beams in the same ping. Alongtrack slopes are determined from the same beam in the previous and subsequent pings. Alongtrack are fairly sensitive to the minimum distance **−D** option, which will normally need to be set less to a very small value for alongtrack slopes to be detected. There is no test that alongtrack distances are all in the same direction.

If *mode* is 1 (default) only acrosstrack spikes are detected. If *mode* is 2 only alongtrack spikes are detected. If *mode* is 3 both along track and across track slopes are checked.

unit is optional and specifies the unit of *slope*, 0 (default) indicates the slope is in tangents, 1 slope is in radians, 2 slope is in degrees. A beam is not considered a spike if either the preceding or subsequent beam has already been flagged. Default: *slope* = 1.0

−T *tolerance*
If requested this option will reset the timestamps of edit events from an existing esf file to exactly match the timestamps of the survey pings. The /fItolerance/fP value sets how close timestamps must be in seconds to be considered a match. This option handles the case where survey data have been processed using non-**MB-System** software and a user is extracting the edits from one set of files with **mbgetesf** and then applying them to another using **mbprocess**.

−U *nmin*
This flag causes **mbclean** to search for port or starboard halves of pings which contain fewer than *nmin* good bathymetry values. All bathymetry values in the affected half-pings are flagged.

−X *zap_beams*
If this option is used, the outermost *zap_beams* at both ends of the swath are flagged as bad; this is useful if the outer beams are known to be unreliable. Default: *zap_beams* = 0.

−V Normally, **mbclean** works "silently" without outputting anything to the stderr stream. If the **−V** flag is given, then **mbclean** works in a "verbose" mode and outputs the program version being used, all error status messages, and the number of beams flagged as bad.

EXAMPLES

Suppose one wishes to do a first pass edit of six Simrad EM300 files in the processing format (format 57). A datalist referencing these six files exists as the file datalist.mb-1 and has the contents:

```
0001_20020424_212920.mb57 57
0002_20020425_011607.mb57 57
0003_20020425_022926.mb57 57
0004_20020425_024336.mb57 57
0005_20020425_034057.mb57 57
0006_20020425_045013.mb57 57
```

Use the following to flag any beams which deviate by more than 20% from the local median depth or which produce a slope greater than 3.5 (74 degrees):

```
mbclean −Idatalist.mb-1 \
        -M1 −C3.5 −D0.01/0.20 \
        -G0.80/1.20
```

The program will output flagging statistics for each file and give totals at the end. If the **−V** option is specified, **mbclean** will also output information for each beam that is flagged. Here is an example of the nonverbose output:

```
Processing 0001_20020424_212920.mb57
908 bathymetry data records processed
0 outer beams zapped
0 beams zapped for too few good beams in ping
0 beams out of acceptable depth range
64 beams out of acceptable fractional depth range
0 beams exceed acceptable deviation from median depth
0 bad rail beams identified
1601 excessive slopes identified        0 excessive spikes identified
1665 beams flagged
0 beams unflagged
0 beams zeroed

Processing 0002_20020425_011607.mb57
259 bathymetry data records processed
0 outer beams zapped
0 beams zapped for too few good beams in ping
0 beams out of acceptable depth range
```

0 beams out of acceptable fractional depth range
0 beams exceed acceptable deviation from median depth
0 bad rail beams identified
242 excessive slopes identified 0 excessive spikes identified
242 beams flagged
0 beams unflagged
0 beams zeroed

Processing 0003_20020425_022926.mb57
65 bathymetry data records processed
0 outer beams zapped
0 beams zapped for too few good beams in ping
0 beams out of acceptable depth range
9 beams out of acceptable fractional depth range
0 beams exceed acceptable deviation from median depth
0 bad rail beams identified
497 excessive slopes identified 0 excessive spikes identified
506 beams flagged
0 beams unflagged
0 beams zeroed

Processing 0004_20020425_024336.mb57
410 bathymetry data records processed
0 outer beams zapped
0 beams zapped for too few good beams in ping
0 beams out of acceptable depth range
0 beams out of acceptable fractional depth range
0 beams exceed acceptable deviation from median depth
0 bad rail beams identified
148 excessive slopes identified 0 excessive spikes identified
148 beams flagged
0 beams unflagged
0 beams zeroed

Processing 0005_20020425_034057.mb57
252 bathymetry data records processed
0 outer beams zapped
0 beams zapped for too few good beams in ping
0 beams out of acceptable depth range
0 beams out of acceptable fractional depth range
0 beams exceed acceptable deviation from median depth
0 bad rail beams identified
100 excessive slopes identified 0 excessive spikes identified
100 beams flagged
0 beams unflagged
0 beams zeroed

Processing 0006_20020425_045013.mb57
562 bathymetry data records processed
0 outer beams zapped
0 beams zapped for too few good beams in ping
0 beams out of acceptable depth range
0 beams out of acceptable fractional depth range
0 beams exceed acceptable deviation from median depth

0 bad rail beams identified
41 excessive slopes identified 0 excessive spikes identified
41 beams flagged
0 beams unflagged
0 beams zeroed

MBclean Processing Totals:
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6 total swath data files processed
2456 total bathymetry data records processed
0 total beams flagged in old esf files
0 total beams unflagged in old esf files
0 total beams zeroed in old esf files
0 total outer beams zapped
0 total beams zapped for too few good beams in ping
0 total beams out of acceptable depth range
73 total beams out of acceptable fractional depth range
0 total beams exceed acceptable deviation from median depth
0 total bad rail beams identified
2629 total excessive slopes identified 0 total excessive spikes identified
2702 total beams flagged
0 total beams unflagged
0 total beams zeroed

SEE ALSO

mbsystem(1), **mbedit**(1), **mbinfo**(1) **mbprocess**(1),

BUGS

The algorithms implemented in **mbclean** simply don't detect all bathymetric artifacts that are obvious to the eye on contour charts. Although **mbclean** often does a credible first pass at flagging obvious artifacts, we strongly recommend that any swath bathymetry processing stream include interactive editing of the bathymetry data (e.g. **mbedit**).