

Processing of AUV Sentry multibeam bathymetry using MB-System

1. Overview

The supplied files describe an automated MB-System workflow used to process Kongsberg KMALL multibeam data acquired by AUV Sentry during dive 638, but is applicable to all datasets acquired during the same expedition. The workflow can be reconstructed as: (1) select/copy the raw KMALL files, (2) merge the vehicle navigation, depth, heading and attitude into the multibeam data with mbpreprocess, (3) automatically flag suspect soundings with mbclean, (4) configure geometric offsets, roll bias and tidal correction, then generate processed bathymetry with mbprocess, and (5) grid and export the cleaned bathymetry with mbgrid and associated MB-System/GMT utilities.

2. Processing parameters and survey definition

A central Python parameter file (mbparam.py) defines the survey extent, processing interval, cleaning thresholds, sensor offsets, gridding resolution and system settings. For this example dataset, the map basename is sentry638_20220530_1538_rnv and the final grid cell size is 1.0 m.

Parameter	Value	Role in processing
Survey interval	2022-05-29 17:13:09 to 2022-05-30 12:01:08	Temporal window used for the survey section
Grid resolution	1.0 × 1.0 m	Output bathymetric grid spacing
Depth limits	3110.3–3362.7 m	Depth-based cleaning bounds
Across-track swath	110 m	Maximum across-track distance retained by mbclean
Beam range	10–250 m	Minimum and maximum acceptable beam range
Maximum heading rate	5°	Cleaning parameter defined in the central configuration
Roll bias	-0.2°	Angular correction applied during mbprocess
Heading / pitch bias	0.0° / 0.0°	No additional heading or pitch correction
Navigation lever arm	X 0 m; Y -1.07 m; Z -0.15 m	Offset from multibeam to DVL reference
Tide position	41.0633233° N, 127.5098272° W	Location used to predict tidal elevation
Processing cores	96	Parallel processing setting used by mbprocess

3. Raw multibeam file extraction / staging

The first script stages the raw multibeam files for processing. It copies .kmall files from the ../raw directory into the working directory and renames each file by adding an “e” before the .kmall extension.

4. Pre-processing and merging of vehicle navigation

The staged multibeam data are passed to `mbpreprocess` using `datalist.preprocess.mb-1`. External Sentry vehicle data are supplied separately for sensor depth, heading, navigation and attitude. All four auxiliary streams use MB-System file format 1, which is applicable to datatlists generated for all files. The command also invokes `--kluge-auv-sentry-sensordepth`, an AUV Sentry-specific handling option for sensor depth.

- Sensor depth: `../nav/sentry638_depth.mbnv`
- Heading: `../nav/sentry638_heading.mbnv`
- Renavigated position: `../nav/sentry638_20220530_1538_navigation.mbnv`
- Attitude: `../nav/sentry638_attitude.mbnv`

Conceptually, this step synchronises the multibeam observations with the best available vehicle position, depth and orientation information so that each sounding can subsequently be positioned and corrected in three dimensions.

5. Automated sounding cleaning

Before final bathymetric processing, previous edit files and previously generated processed files are removed. In particular, existing `.esf` edit-save files are deleted, meaning that any earlier manual edits would be discarded if this script were run unchanged. `mbclean` is then run in parallel on every `*e.mb261` file.

The `mbclean` command applies a set of automatic filters intended to identify geometrically inconsistent or implausible soundings. The supplied command contains the following numerical criteria:

mbclean option	Function in this workflow
<code>-Q2.0/10/1000/250.0/1.0</code>	Across-track/range consistency test using the configured 2.0 m backup allowance, 10 m range-jump threshold, 1000 m depth-jump threshold, 250 m maximum range and 1.0 maximum-range fraction.
<code>-B3110.3/3362.7</code>	Flags soundings outside the specified bathymetric depth interval.
<code>-K10.0</code>	Applies the 10 m minimum beam-range criterion.
<code>-X1</code>	Removes/flags one outer beam at the swath edge.
<code>-R5.0</code>	Uses the configured maximum heading-rate threshold of 5.0.
<code>-E110.0</code>	Limits the retained across-track swath to 110 m.

These descriptions follow the intent documented in the supplied central parameter file. The scripts do not record any subsequent manual `mbedit`/`mbeditviz` cleaning, so such editing should not be claimed unless it is documented elsewhere.

6. Tidal correction

A tidal time series is generated separately in MATLAB. The script creates timestamps at 60 s intervals and calls `tide_pred` using the TPXO6.2 tidal model at approximately 41.0633° N, 127.5098° W. The predicted elevation (`z1`), timestamps and tidal constituents are saved to `mat_tidemodel`. The supplied processing configuration subsequently identifies `sentry638.tide` as the tide file used by MB-System. The intermediate conversion from the MATLAB output to `sentry638.tide` is not present in the supplied files, so its exact formatting step cannot be reconstructed from these materials alone.

7. Final bathymetric processing with mbprocess

mbset writes the processing parameters associated with the files in `datalist.process.bathy.mb-1`. The configured corrections are: zero heading and pitch bias; zero VRU offsets; a navigation lever-arm correction of $X = 0$ m, $Y = -1.07$ m and $Z = -0.15$ m; and a roll bias of -0.2° . Tidal correction is enabled (TIDEMODE:1) using `../proc/sentry638.tide`.

Lock files and any earlier `*p.mb261` products are then removed and `mbprocess` is run on the bathymetry datalist using 96 processing cores. This produces the processed MB-System bathymetry files with the configured navigation, attitude, geometry, edit flags and tide correction applied.

8. Gridding and map products

The processed bathymetry is gridded from `datalist.grd.mb-1` with `mbgrid`. The principal grid uses a 1.0×1.0 m cell size and is written as a GMT netCDF grid. A second equal-sized grid is also generated for export to ESRI ASCII format. The gridding command uses MB-System option `-F5` and the parameters `-A2`, `-C2`, `-X0.25`, `-Bp0.5m`, `-N` and `-U`; the supplied script records these settings but does not itself explain their scientific rationale. The workflow then creates several derivative/export products:

- An ESRI ASCII grid (.asc) using `mbm_grd2arc`.
- A GMT grid converted for Fledermaus using `gmt_grdconvert`.
- A bathymetry plot generated through `mbm_grdplot`, with 12 m contour spacing.
- A PDF map converted from the PostScript plot using `gmt_psconvert`.
- A slope-shaded GeoTIFF generated with `mbm_grdtiff` and its generated command script.

9. Reconstructed workflow summary

Step	Stage	Operation
1	Stage raw data	Copy 78 selected Sentry KMALL files from the raw directory into the processing workspace.
2	Merge vehicle data	Use <code>mbpreprocess</code> to merge sensor depth, heading, renavigated position and attitude with the multibeam records.
3	Automatic cleaning	Clear previous edit products and run <code>mbclean</code> with depth, range, swath, heading-rate and outer-beam filters.
4	Generate tide	Predict a 1-minute tidal time series from TPXO6.2 at the survey location; convert/use this as <code>sentry638.tide</code> .
5	Set corrections	Apply lever-arm offsets, -0.2° roll bias, zero heading/pitch bias and enable tidal correction using <code>mbset</code> .
6	Process bathymetry	Run <code>mbprocess</code> to generate corrected processed MB-System files.
7	Grid	Grid processed soundings at 1 m resolution with <code>mbgrid</code> .
8	Export/visualise	Create ASCII, GMT/Fledermaus, PDF and slope GeoTIFF products.