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The Bathymetric and Reflectivity-based Estimator for Seafloor Segments (BRESS) library provides tools for seafloor segmentation.

**BRESS** takes a DTM and (optionally) an acoustic backscatter mosaic to identify seafloor segments and provides statistical layers that characterize the segments.
2.1 Inputs/Outputs

This tab is mainly used to define the input bathymetry and acoustic backscatter, by selecting files in ASCII grid (.asc) or native formats (.bathy and .mosaic), as well as set the location for outputs.

To access these functionalities, you need to select the BRESS tab on top of the application, then the Inputs/Outputs sub-tab at the lower-left corner.

Note: The native formats (.bathy and .mosaic) are internal binary formats that have been introduced to speed up the reading in memory for gridded data of large size. The app provides a conversion tool in these native formats.

2.1.1 Data Inputs

In Data inputs:

- Drag-and-drop a bathymetric DTM (.asc or .bathy) in the Bathy DTM field. The “+” browse button may also be used.
- Optionally, drag-and-drop a flatness grid (.asc or .flatness) in the Flatness Grid field. The “+” browse button may also be used.
- Drag-and-drop a reflectivity grid (.asc or .mosaic) in the Reflectivity field. The “+” browse button may also be used.
- The directory and filename of loaded data will populate in the respective field of Data inputs.
- With the addition of a bathymetric DTM grid, the Landforms tab on the bottom of the interface will become available (Fig. 2.1).
- When both a bathymetric DTM and a reflectivity grid are loaded, the Segments tab on the bottom of the interface will become available (Fig. 2.1).
- The Clear data button may be used to remove all data inputs.
- The Info button provides a link to the present manual.
- Additional functionalities are available by right-clicking on the loaded DTM (Fig. 2.2) and mosaic (Fig. 2.3):
  - Read as depths/Read as elevations (only for DTM’s ASCII grid). To be used in case that the values represent depths (positive down), not elevations (positive up, that is the default).
  - Plot the DTM (Fig. 2.4) or the mosaic (Fig. 2.5).
  - Edit. To open the DTM in the Gridy tool for editing.
Fig. 2.1: Data Inputs tab.
– **Show mask path** (only if a DTM’s mask is loaded).
– **Set mask/Unset mask** (only for DTM’s ASCII grid). To pair/unpair the DTM with a landform mask.
– **Save** the DTM or the mosaic in the native binary formats (.bathy and .mosaic, respectively).
– **Remove** the selected input.

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**Fig. 2.2**: Context menu accessible by right-clicking on a loaded DTM input.

**Fig. 2.3**: Context menu accessible by right-clicking on a loaded mosaic input.

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### 2.1.2 Data Outputs

In **Data outputs**:

- The output ** Formats ** currently available are ASCII grid (.asc) and floating-point GeoTiff (.tiff).
- The default output ** Folder ** location is listed; however, this may be modified via drag-and-drop (or browse to) a user-specified output folder. To return to the default output folder location, click ** Use default. **
- The ensuing functions will open the output folder automatically upon execution; however, if needed, the specified output folder may be accessed by clicking the ** Open folder ** button.
- The ** Info ** button provides a link to the present manual.
Fig. 2.4: Plot showing the loaded DTM.
Fig. 2.5: Plot showing the loaded mosaic.
2.2 Landforms

This tool mainly classifies bathymetric DTM based on landform type, (optionally) calculates pattern-based statistics, and creates area kernels (connected grid nodes with the same landform type).

2.2.1 How To Use?

- Select the **Landforms** tab (Fig. 2.6) on the bottom of the BRESS interface.
- To change the **Settings** for **Landforms v3**:
  - Click the **Unlock** button, and click **OK** to the dialogue.
  - **Set**:
    - The inner and outer radii of the search annulus.
    - The flatness angle and (if the **Apply correction for extended forms** is flagged) the flatness distance.
    - When the **Adaptive flatness** is flagged, the **Outer multiplier** for the outer radius and the adopted **Percentile** (in ascending order) to estimate the flatness angle.
    - The kind of landform classification in the **Landform classification** list. The default is a 6-type look-up table (Fig. 2.12).
  - **If required, select the following optional flags**:
    - **Search distance in meters**: When flagged, the values in the search annulus are evaluated as meters. Otherwise, number of nodes.
    - **Adaptive flatness**: When flagged, the flatness angle is estimated node by node, using the **Outer multiplier** and the **Percentile** fields.
    - **Delta angle for openness**: When flagged, a pattern direction is evaluated positive (or negative) when the delta between the zenith and nadir angles is larger than the selected flatness angle.
    - **Extended-form correction**: When flagged, the flatness distance is used as the limit at which to increase the threshold height to evaluate a positive (or negative) direction.
    - **Grid-edge correction**: When activated, all the nodes with less than eight valid directions are ignored.
  - **The tool can provide the following kinds of outputs (and they can be both saved as ASCII grids or plotted)**:
    - **Flatness angles** used to calculate the landforms.
    - **Landform classification** (see Landforms).
    - **Statistical layers** (see Statistical layers).
    - **Area kernels** (see Area kernels).
- To reset the **Parameters** to the default initial values, click the **Reset** button.
- In **Execution**, click **Landforms v2**.
Fig. 2.6: The **Landforms** tab.
2.2.2 How Does It Work?

Local Ternary Patterns

The first step of this tool is to calculate the Local Ternary Pattern (LTP) for each node and in the eight surrounding major directions (Fig. 2.7). The openness of each direction is evaluated by comparing the zenith and nadir angles against the flatness angle (Fig. 2.8).

Fig. 2.7: Example of a LTP of a given node.

Fig. 2.8: Example of a profile looking at just one of the eight directions.
Bathymorphons

The possible 6,561 values of LTP are reduced to 498 bathymorphons by removing the duplications after rotating and mirroring the patterns.

Landforms

The landform classification is obtained by counting the number of positive and negative directions. The number of positive and negative directions are then used to look up in one of the four following tables:

- a 10-type landform-classification table (FL: Flat, PK: Peak, RI: Ridge, SH: Shoulder, CV: Convex Slope, SL: Slope, CN: Concave Slope, FS: Footslope, VL: Valley, PT: Pit) (Fig. 2.9).
- a simplified 6-type landform-classification table (FL, RI, SH, SL, FS, VL) (Fig. 2.10).
- a simplified 5-type landform-classification table (PK, FL, RI, SL, VL) (Fig. 2.11).
- a simplified 4-type landform-classification table (FL, RI, SL, VL) (Fig. 2.12).

Statistical layers

During the calculation of the local ternary patterns, the neighborhood of each grid node is analyzed in the main eight surrounding directions. The analysis requires the calculation of the local height, that is the relative elevation of the neighborhood nodes compared to the node being analyzed.
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Fig. 2.10: The 6-type landform classification table. For more details, see *(Masetti et al., 2018).*
Fig. 2.11: The 5-type landform classification table.
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Fig. 2.12: The 4-type landform classification table.
In each direction, the analysis identifies a node (within the search annulus) that is used to evaluate the openness of the visible neighborhood. The **patterns polygon** is constructed by connecting these nodes.

During the analysis, a number of statistics are calculated for each grid node:

- **Local Ternary Pattern** (see *Local Ternary Patterns*).
- **Bathymorphon** (see *Bathymorphons*).
- **Valid Patterns**: the number of valid *LTPs* (that is, number of directions along which the openness can be evaluated).
- **Positives**: the number of directions with zenith angle larger than the selected flatness threshold.
- **Negatives**: the number of directions with nadir angle larger than the selected flatness threshold.
- **Average Height**: the average height of the visible neighborhood.
- **Maximum Delta**: the maximum elevation delta (that is, the absolute value of the height) of the visible neighborhood.
- **Height Range**: the height range of the visible neighborhood.
- **Height Variance**: the height variance (calculated using the Average Height as mean value) of the visible neighborhood.
- **Average Azimuth**: the average orientation of the patterns polygon.
- **Elongation Ratio**: the ratio between the maximum and the minimum dimensions of the patterns polygon.
- **Maximum Width**: the maximum dimension (x- vs. y-direction) of the patterns polygon.
- **Area Ratio**: the ratio between the area of the patterns polygon and its maximum possible extension (based on the outer search radius).

**Area kernels**

An **area kernel** is created by connecting all the adjacent nodes (Fig. 2.13) that have the same landform classification.

![Fig. 2.13: An example of adjacent nodes classified as “FL” (flat) and thus clustered into the same area kernel.](image-url)
2.3 Segments

This tool segments the seafloor based on elevation and reflectivity values. It extends the functionalities provided by the Landforms tool (see Landforms) by analyzing the reflectivity values co-located with the elevation nodes that belong to each area kernel.

2.3.1 How To Use?

- Select the Segments tab (Fig. 2.14) on the bottom of the BRESS interface.
- In Setting, check the settings of your choice.
- To change the Settings for Segments v2:
  - Click the Unlock button, and click OK to the dialogue.
  - The parameters in common with the Landforms tool are described in Landforms.
  - The reflectivity Histogram (see Reflectivity Histogram) can be customized by modifying:
    * The min and the max fields that represent the minimum and the maximum values for the histogram’s bins.
    * The nr.bins field sets the number of bins in which the range between the minimum and the maximum values on the histogram are split.
  - The range percentage and the delta bins fields are used in the Splitting processing step (see Area Kernels Splitting) to identify peaks in the reflectivity histogram of each area kernel.
  - The intersection and the min.samples fields are used during the Merging processing step (see Area Kernels Merging) to identify the area kernels that can be merged together due to similarity in the reflectivity texture.
  - In addition to the Landforms products, the tool can provide the following three kinds of outputs (and they can be saved as ASCII grids or plotted):
    * Segments (see Segments).
    * Segments Statistics (see Segments Statistics).
    * Mosaic mask (see Mosaic Mask).
    * Cropped DTM (see Cropped DTM).
- To reset the Parameters to the default, initial values, click the Reset button.
- In Execution, click Segments v2.
2.3. Segments

Fig. 2.14: The **Segments** tab.
2.3.2 How Does It Work?

Reflectivity Histogram

The Reflectivity Histogram is used to characterize the texture in each area kernel.

Area Kernels Splitting

The splitting step evaluates the reflectivity histogram of each area kernel to identify multi-modality (that is, multiple peaks) (see Fig. 2.15).

The range percentage value is used to identify a threshold density (as a percentage of the dynamic range of each histogram) for classifying potential peaks (and, thus, multi-modality) in an area kernel.

The delta bins value represents a filter that removes peaks that have an higher peak in the surrounding histogram bins.

Area Kernels Merging

The merging step compares pairs of reflectivity histograms to detect similarity in reflectivity textures (see Fig. 2.16).

The intersection value provides the criterion used to evaluate if a pair of reflectivity histograms are similar enough to be classified as part of the same segment.

The min.samples value is used to ignore the area kernels that are too small in size to have a reliable reflectivity histogram.

Segments

A segment represents an area that has been classified with the same landform type and similar reflectivity texture.

Fig. 2.15: An example of reflectivity histogram with two detected peaks.
Fig. 2.16: An example of histogram comparison. The pair of reflectivity histograms has an intersection value of 71.56%.

**Segments Statistics**

The statistics for each segment are optionally calculated and stored in a .csv file. The statistical values (i.e., median, mean, and standard deviation) are based on the mosaic values and the Statistical layers of all the valid nodes in a segment.

**Mosaic Mask**

The mosaic mask has the same information as segments, but resampled at the resolution of the input reflectivity grid. It is usually used for theme-based seafloor characterization.

**Cropped DTM**

The cropped DTM is obtained by removing all the unclassified nodes from the input elevation grid.

### 2.4 Info Tab

The Info tab (Fig. 2.17) contains numerous helpful links and utilities:

- The application home page
- The Online User Manual (it requires an Internet connection)
- The Offline User Manual (in PDF format, it does not require an Internet connection)
- A Bug Report form (it is the suggested mean to submit a possible bug in the application)
- The HydrOffice home page
- The Center for Coastal and Ocean Mapping home page
• The University of New Hampshire home page
• The License information
• The Contacts information and the Authors List
• An About dialog (with details on the local environment where the application is running)

2.5 Gridy tool

Gridy is a simple tool to visualize and edit grid files (Fig. 2.18).

2.5.1 Input toolbar

The Input toolbar (Fig. 2.19) is mainly used to load/unload input files, and retrieve general information about them (Fig. 2.20).
2.5. Gridy tool

Fig. 2.18: The Gridy tool.

Fig. 2.19: The Input toolbar.
2.5.2 Edit toolbar

The Edit toolbar (Fig. 2.21) provides access to several editing tools:

- Colormap tool.
- Shift tool.
- Modify tool.
- Erase tool.
- Mask tool.

Fig. 2.20: Example of histogram created by Gridy.

Fig. 2.21: The Edit toolbar.
LIST OF REFERENCES


CHAPTER
FOUR

DEVELOPMENT NOTES

N/A
CHAPTER

FIVE

HOW TO CONTRIBUTE

Every open source project lives from the generous help by contributors that sacrifice their time and this is no different. To make participation as pleasant as possible, this project adheres to the Code of Conduct by the Python Software Foundation.

Here are a few hints and rules to get you started:

- Add yourself to the AUTHORS.txt file in an alphabetical fashion. Every contribution is valuable and shall be credited.
- If your change is noteworthy, add an entry to the changelog.
- No contribution is too small; please submit as many fixes for typos and grammar bloopers as you can!
- Don’t ever break backward compatibility.
- Always add tests and docs for your code. This is a hard rule; patches with missing tests or documentation won’t be merged. If a feature is not tested or documented, it does not exist.
- Obey PEP 8 and PEP 257.
- Write good commit messages.
- Ideally, collapse your commits, i.e. make your pull requests just one commit.

Note: If you have something great but aren’t sure whether it adheres – or even can adhere – to the rules above: please submit a pull request anyway! In the best case, we can mold it into something, in the worst case the pull request gets politely closed. There’s absolutely nothing to fear.

Thank you for considering to contribute! If you have any question or concerns, feel free to reach out to us.
CHAPTER SIX

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Version 3, 29 June 2007

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BRESS is a project developed by the UNH’s Center for Coastal and Ocean Mapping.

For bugs and feature requests: hydrooffice.oceano@ccom.unh.edu

Feel free to contact us for comments and suggestions:

- Giuseppe Masetti
- Larry Mayer
- Larry Ward

The following wonderful people contributed directly or indirectly to this project:

- Laura Kracker
- Derek Sowers