Boreas User Guide

1 Boreas User Guide

Boreas is a standalone application that facilitates the use of Progressive Thresholding Marker-Controlled Watershed (PTMCW) segmentation for Arctic Sea Floe Images. The workflow for completing this segmentation is shown in figure 2. The use of Boreas allows for both a simple user experience and the ability to tweak parameters to affect the produced results. This sees the ability to go straight from a progressive thresholded image to a segmented result or to fine-tune each stage of the process while observing the produced results.

Boreas also allows for data to be saved and loaded to enable work to be carried out and saved for multiple configurations and/or images across multiple processing sessions. Loading data will see Boreas configure itself to match the completed processing stored in the loaded data. This also allows for improvements in processing times is later stages as it means that the longest stage of processing, the progressive thresholding, needs only be executed once then the results saved. This then allows for fine-tuning to be carried out far faster. The tuning of the parameters relating to the threshold level and floe separation are vital to the final segmentation results. This is due to these image being used to generate the foreground and background segmentation markers respectively.

An annotated overview of the Boreas main window once an image has been loaded is provide in figure 1. Boreas displays a visual indicator as to its current status via the light in

bottom right of the application as in figure 1. This allows for the user to easily determine if Boreas is completing background processing. The indicator light will be red when Boreas is currently performing background processing, and green when ready for input.

In addition to the indicator light the Boreas user experience has been configured to only allow for operations to be performed when their requirements are met and/or the result would see a meaningful update. This means that if a button is greyed out and cannot be used that either prerequisites have not been met to enable its use or that repeating the operation would produce no changes. Refer to the functions respective section if there is any confusion as to why it cannot be used.
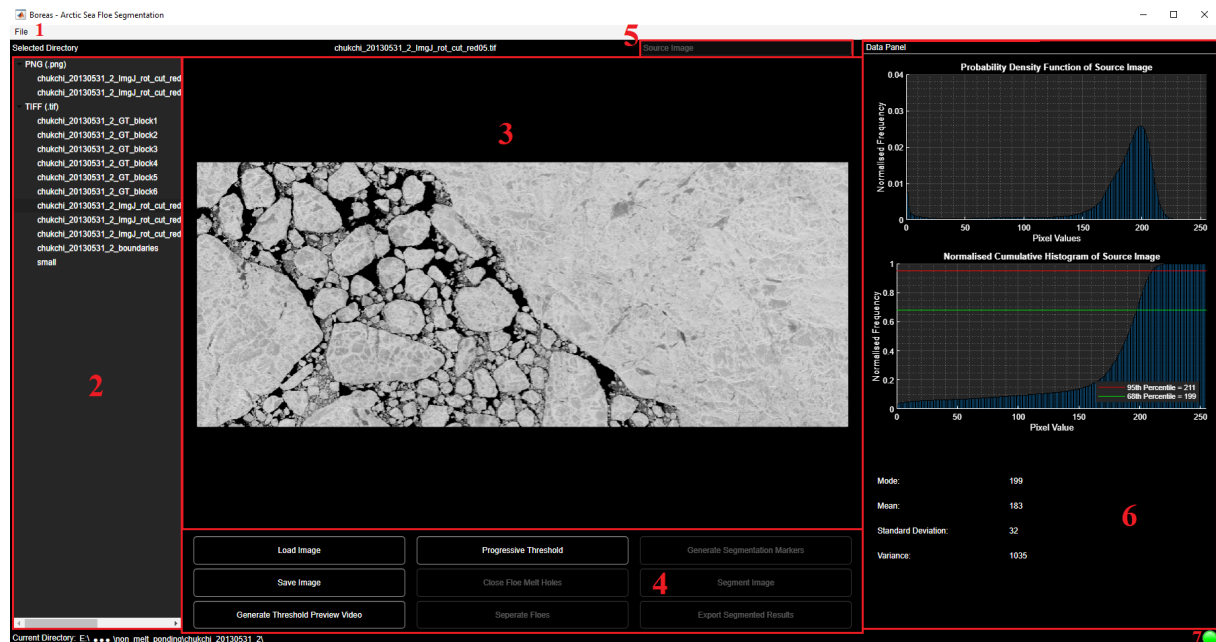

Figure 1: *Boreas Main Window Overview. (1) File Taskbar Menu. (2) Loaded Directory File Tree. (3) Image Viewer. (4) Main Controls. (5) Image Viewer Selector Drop Down. (6) Data Panel. (7) Process Indicator Lamp.*
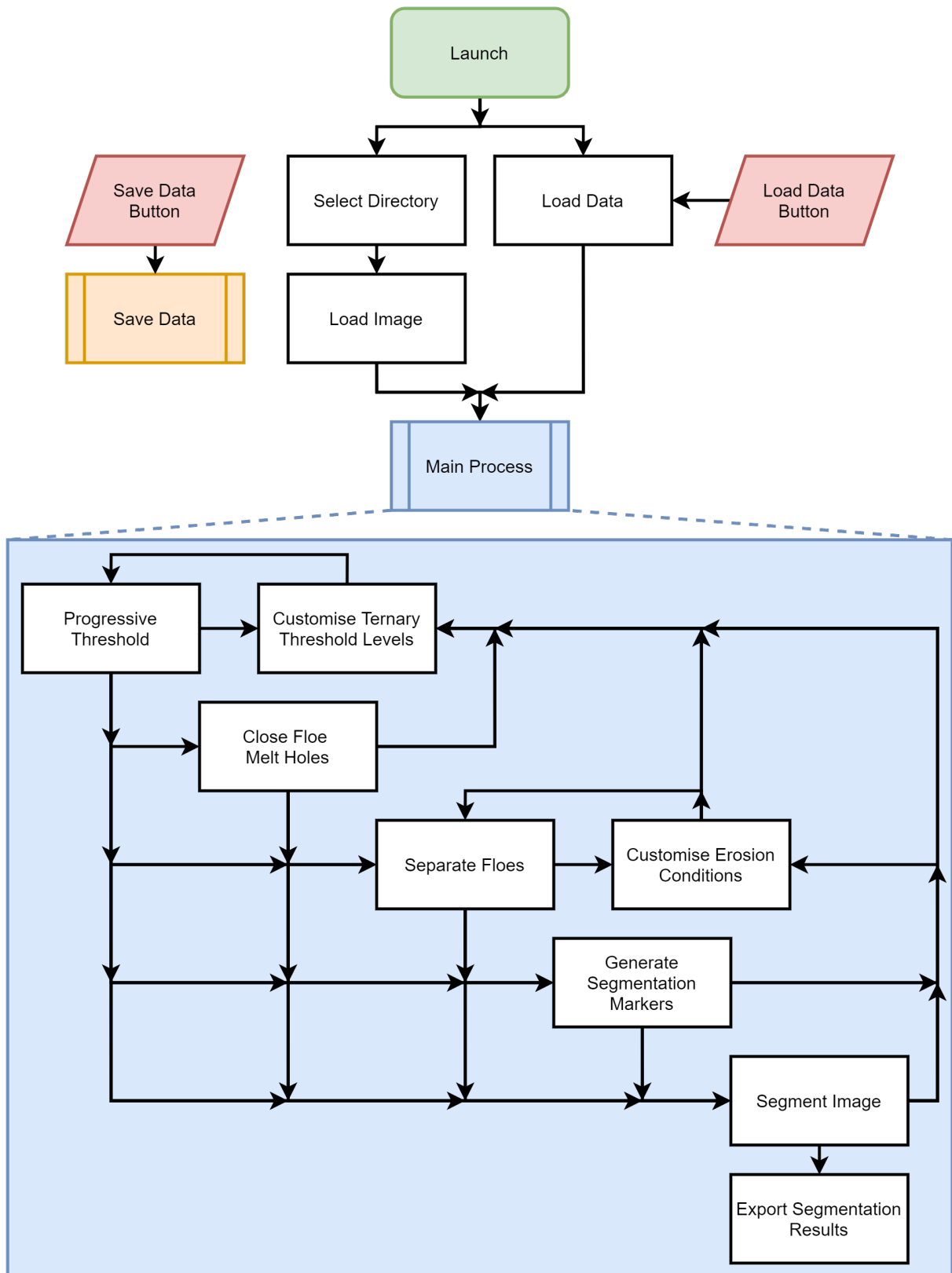
Figure 2: *Boreas Workflow.*

1.1   Loading Images

To load an image into Boreas a file directory must first be selected. This can be achieved by selecting the `Select Directory` field from the drop down `File` menu on the Boreas taskbar as shown in figure 3.
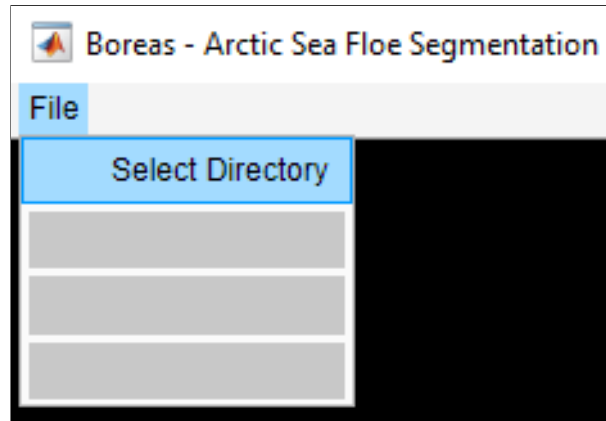

Figure 3: *Boreas File Directory Selection.*

All images of supported file types will then be provided in the file tree as shown located at (2) in figure 1 where the desired image can be selected and the `Load Image` button pressed to import the image. The loaded image will then be displayed along with relevant data points in the data panel.

1.2   Saving Data

Boreas allows the user to save data for any completed processing. This allows for the user to easily switch between images, and processing sessions without repeating previously completed steps. The Boreas data can be saved from any stage after the completion of the progressive thresholding.

To save the current data, select the `Save Data` field from the drop down `File` menu on the Boreas taskbar as shown in figure 4. This will open a system dialogue window allowing for the data to be saved in a desired location.

The saved data will be stored as a `.mat` file which can be opened independently using MATLAB. Note that to open the data correctly outside of the Boreas application the source processing class is required.
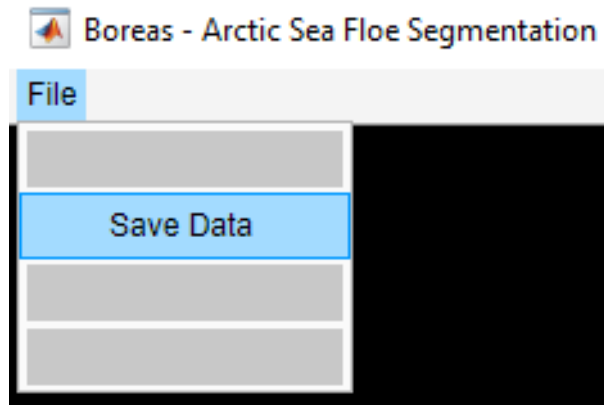
Figure 4: *Boreas Save Data Function.*

1.3   Loading Data

Previously saved Boreas data, as produced in section 1.2 can be loaded at any time. To load data select the `Load Data` field from the drop down `File` menu on the Boreas taskbar as shown in figure 5. This will launch a system dialogue window allowing for the selection of a `.mat` file.
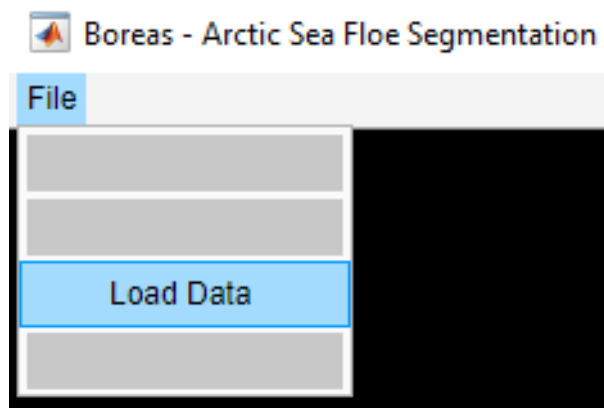

Figure 5: *Boreas Load Data Function.*

If a valid data (`.mat`) file is loaded then the previously completed processing steps will be determined and the Boreas application configured appropriately. Boreas will initially display the source image, with all other images available through the image view selector as described in section 1.5.

1.4   Progressive Threshold

To perform progressive thresholding a source image or data must be loaded. This process may require an extended period to complete, with the application activity indicated via the

light in the bottom right of the Boreas window, as discussed in section 1.

Upon completion of the progressive thresholding, the number of regions and region merges across all thresholds will be displayed as well as the determined threshold values for ice and melt ice. These threshold values can be overridden as covered in section 1.8.

1.5   Switching Image View

Once any processing stages after the initial image import has been completed the main image viewer can switch between various images. This is achieved by selecting an image from the image viewer drop down menu as indicated in figure 6 and located at (5) in figure 1.

The available images provided by the menu is dependent upon the completed processing steps, the images available after each process are shown in table 1.
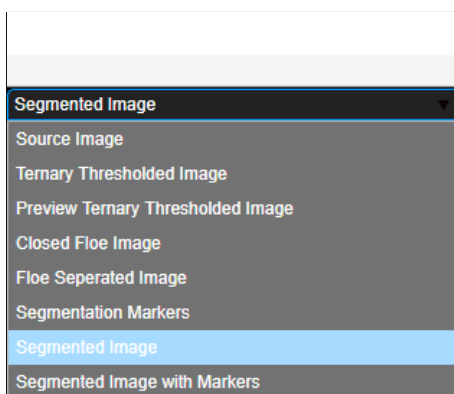

Figure 6: *Boreas Image Viewer Selection Drop Down Menu.*

Table 1: *Boreas Available Images after Respective Processing Tasks. Images shown in bold indicate the default view after process completion. Images shown in italics are dependent on an optional earlier process so may not always be available.*

Completed Process	Available Images
Load Image	**Source Image**
Progressive Threshold	Source Image **Ternary Thresholded Image**
Preview Ternary Levels	Source Image Ternary Thresholded Image **Preview Ternary Thresholded Image**
Override Ternary Levels	Source Image **Ternary Thresholded Image**
Close Floe Melt Holes	Source Image Ternary Thresholded Image *Preview Ternary Thresholded Image* **Closed Floe Image**
Separate Floes	Source Image Ternary Thresholded Image *Preview Ternary Thresholded Image* Closed Floe Image **Floe Separated Image**
Generate Segmentation Markers	Source Image Ternary Thresholded Image *Preview Ternary Thresholded Image* Closed Floe Image Floe Separated Image **Segmentation Markers**
Segment Images	Source Image Ternary Thresholded Image *Preview Ternary Thresholded Image* Closed Floe Image Floe Separated Image Segmentation Markers **Segmented Image** Segmented Images with Markers

1.6   Saving Images

The `Save Image` button can be used at any stage after a image has been imported. This function allows for the image currently displayed in the image viewer to be exported in a range of image formats. Selecting this button will open a system dialogue window allowing for the desired file name, type, and directory to be specified.

1.7   Generating Threshold Previews

The generate threshold preview video button will take the currently loaded image and threshold it across the range [1:255]. The resultant images are combined into a MPEG4 H.264 video

with annotations indicating the respective threshold level and number of regions present. An example of a frame from a generated preview video is shown in figure 7. The generated video file size is dependent on the size of the image utilised. To generate a threshold preview video a image must be currently loaded.
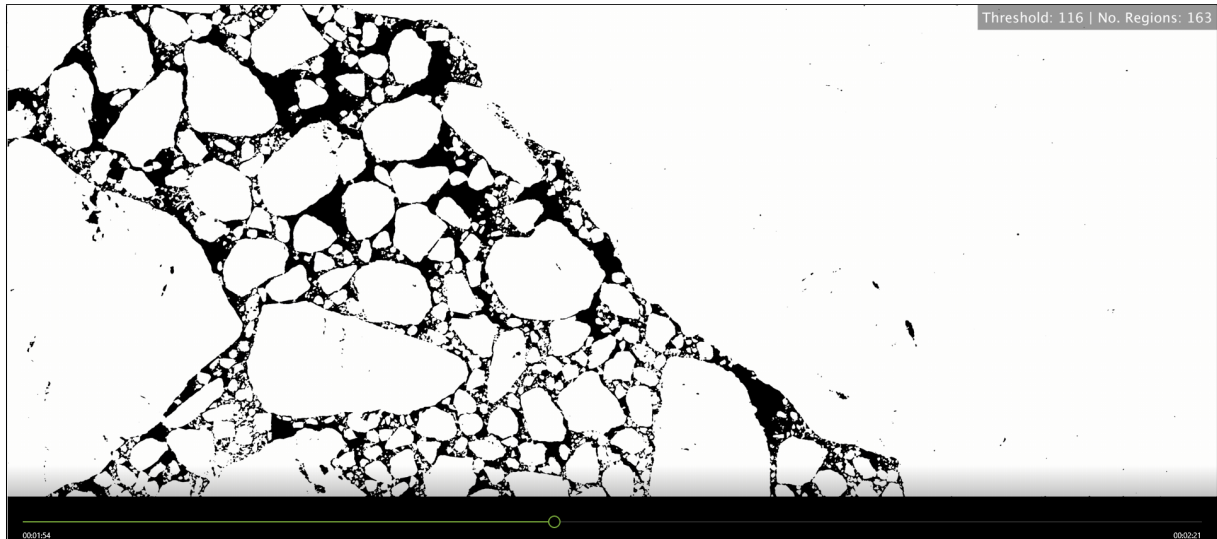

Figure 7: *Boreas Threshold Preview Video Excerpt.*

1.8　Custom Ternary Threshold

Custom ternary threshold values can be specified once the progressive threshold has been completed. The ice and melt level values can be entered into the respective boxes as shown in figure 8. Once a custom value has been entered the `Preview Ternary Levels` and `Override Ternary Levels` buttons will enable.

If the custom values are previewed then a custom ternary threshold image will be available from the image selector as in section 1.5. If the threshold values are preferred to the base progressive threshold then the values can be used to override the progressive threshold ternary image. It may be desirable to customise the ternary threshold values to improve the results of the later floe melt hole closure and floe separation process of sections 1.9 and 1.10 respectively.
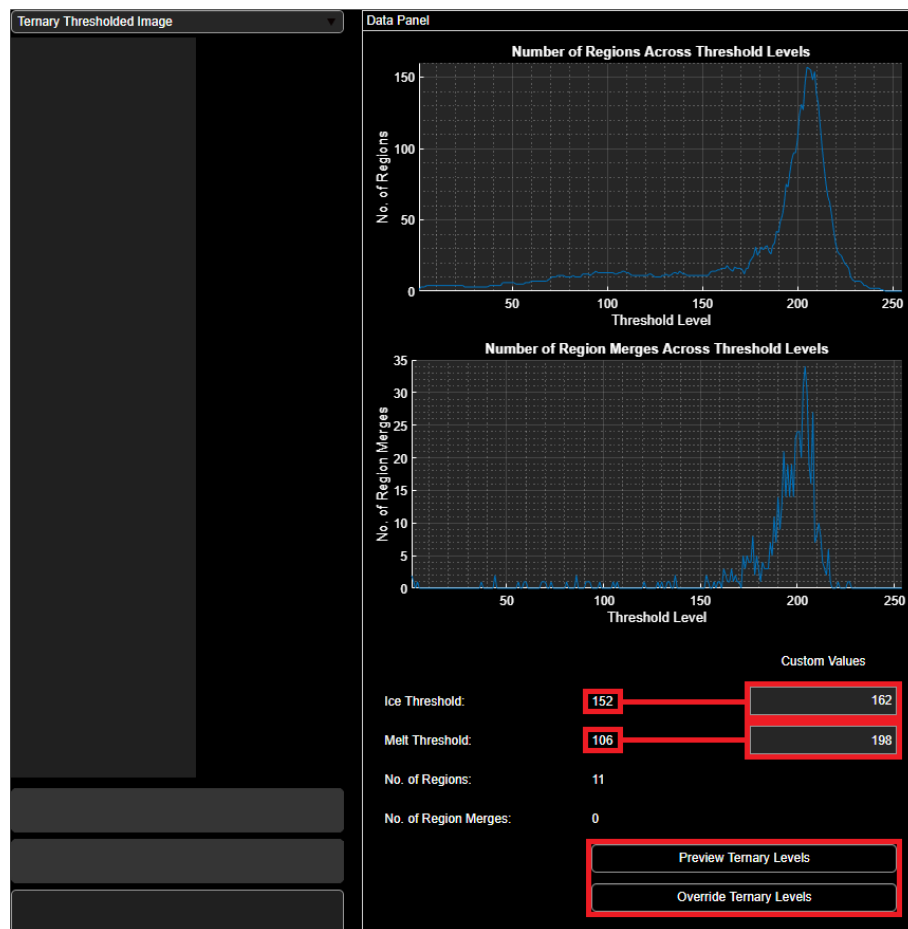
Figure 8: *Boreas Custom Ternary Threshold Level Control.*

1.9   Floe Melt Hole Closure

The melt pond holes in floes can be closed with sufficient melt data once the progressive threshold has been completed. This stage can greatly reduce the time required and observed results for the later floe separation of section 1.10. This improvement is achieved by improving the accuracy of the erosion applied during floe separation.

The floe melt hole closure sees any melt level pixels in fully enclosed holes within floes changed to be ice. This means that if there is a fully enclosed floe hole with missing or no melt pixels then it will not be fully closed or closed at all. If further floe melt hole closure is required reduce the melt level threshold of the ternary thresholded image as in section 1.8.

1.10   Floe Separation

Floe separation can be completed once progressive thresholding and/or floe melt hole closure has been completed. This process aims to separate floes to generate background markers

for segmentation. This has a large impact on the final segmentation and so the conditions that are considered for the employed erosion can be customised as in figure 9.
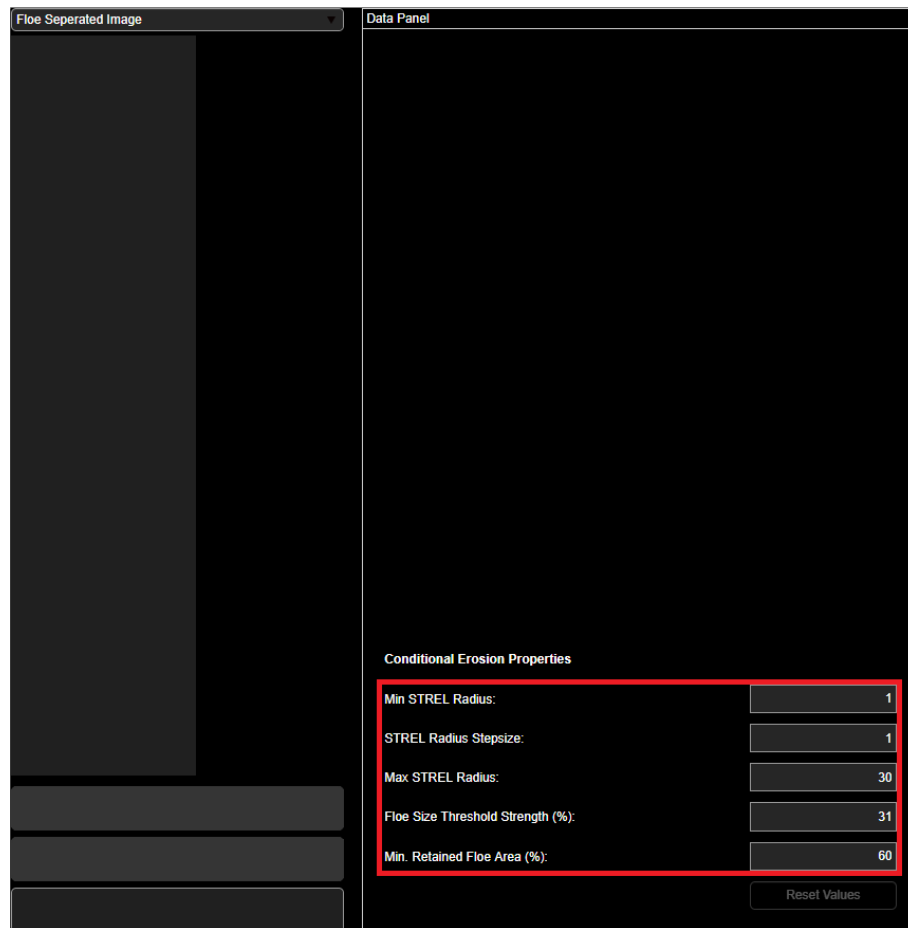

Figure 9: *Boreas Floe Separation Control.*

The employed disk morphological STRucturing ELement (STREL) varies across a range of values. The minimum, maximum, and the incremental increase between the values can be specified.

The `Floe Size Threshold Strength` relates to the minimum area a floe must be to consider it for erosion with each erosion iteration. Increasing this value will see smaller floes ignored.

The `Min. Retained Floe Area` relates to the percentage area that must be retained after each STREL radius has been applied to a region. Increasing this value will reduce the overall strength of the erosion.

All entry boxes provide the input constraints if hovered over, or if attempting to enter a value outside of acceptable ranges.

1.11   Segmentation Marker Generation

The segmentation markers can be generated at any stage after progressive thresholding has been completed. This will complete all prior stages that have not already been completed; floe melt hole closure, and floe separation. Once the segmentation markers have been generated all the completed stages will be viewable from the image viewer selector as in section 1.5. The segmentation markers are provided overlaid on the source image with yellow indicating background markers and green indicating foreground markers.

The segmentation markers are both determined from the results of the floe separation process, and so to adjust the markers the prior stages can be tuned to see increased of decreased floe separation and/or floe melt hole closure.

1.12   Segmentation

Image segmentation can be started at any stage after progressive thresholding has been completed. This will complete all prior stages that have not already been completed; floe melt hole closure, floe separation, and segmentation marker generation. Once the segmentation has been completed all the completed stages will be viewable from the image viewer selector as in section 1.5. The segmentation results are presented as the base image with red boundaries, and the base image with red boundaries, yellow background markers, and green foreground markers.

1.13   Region Investigation

Once the loaded image has been segmented the individual regions can be investigated. This will present the regions pixel distribution, properties, area, and diameter. This can be achieved from either the segmented image view or the segmented image with markers view. Press the `Select Region` button as in figure 10 and then click on a region in the image viewer. The image can be at any zoom stage for region selection.
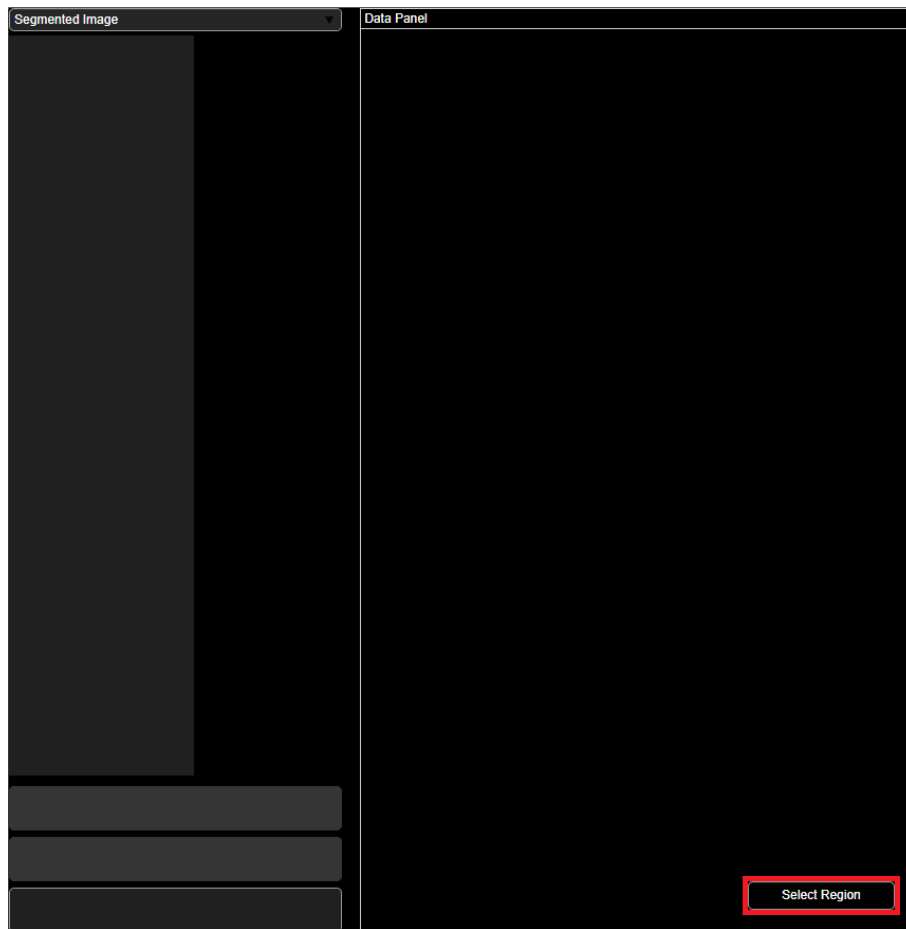
Figure 10: *Boreas Segmented Region Selection.*

1.14   Exporting Segmented Label Image

The final segmentation result can be exported as an label image which sees each individual region assigned a unique numerical index. This label image can then be used for further analysis or processing. The label image can be exported once a image has been segmented, by selecting the `Export Segmented Results`

button from the main controls. This will open a system dialogue windows allowing for a `.mat` file containing the label image to be saved.