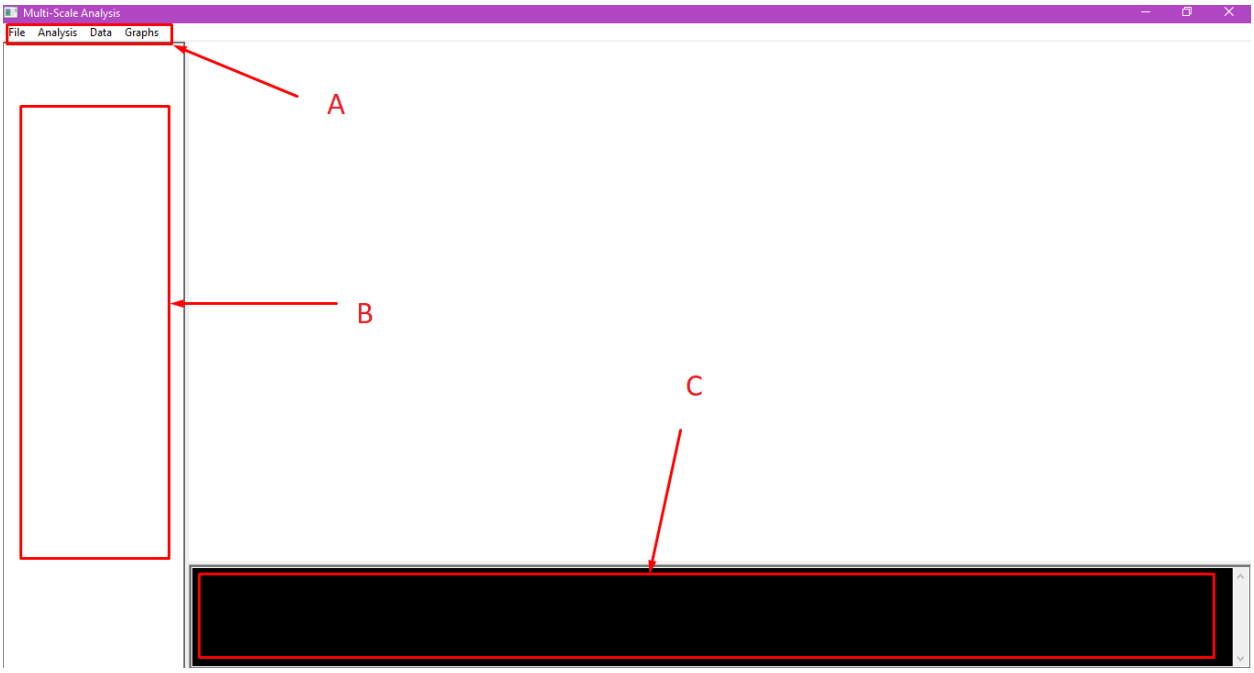
Multiscale Regression Analysis Software

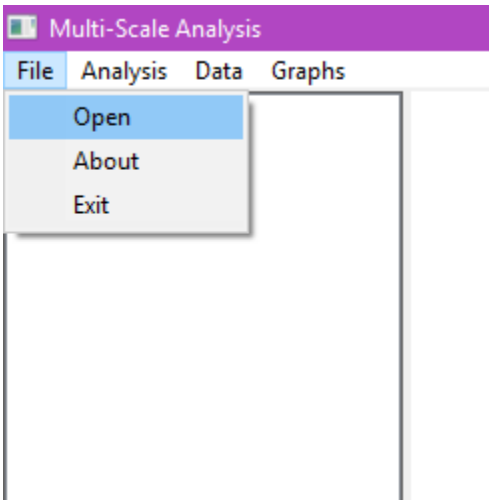
Note: multiple windows in the software have 'Help' buttons on them. These buttons currently have no functionality but all current features are described below with examples.

Open the multiscale regression analysis software.



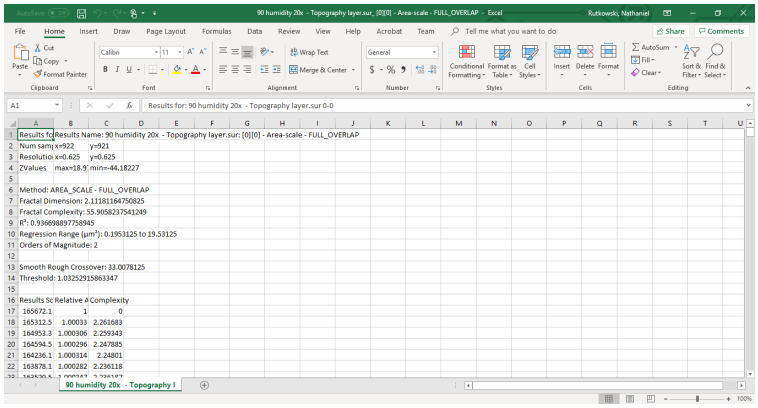
1. Interface – Description
    A. Menu Bar – Access to 'File', 'Analysis', 'Data', and 'Graphs' options. See section 2 'Getting Started 'and section 3 'Analysis' for more details.
    B. Graph Side Menu – When a graph is created it will appear on the left. It can easily be accessed by left double-clicking on the graph names.
        a. Left clicking once on a graph will select it and it will be highlighted in blue. If you left click the selected graph again you can edit the label of the graph in the menu.
    C. Log Window – This window will log events and errors as they occur in the software. If the software doesn't function as expected errors will appear in this window. Refer to the 'Errors' section of this manual for explanations.

2. Getting Started
    a. File – 3 options in the drop-down menu

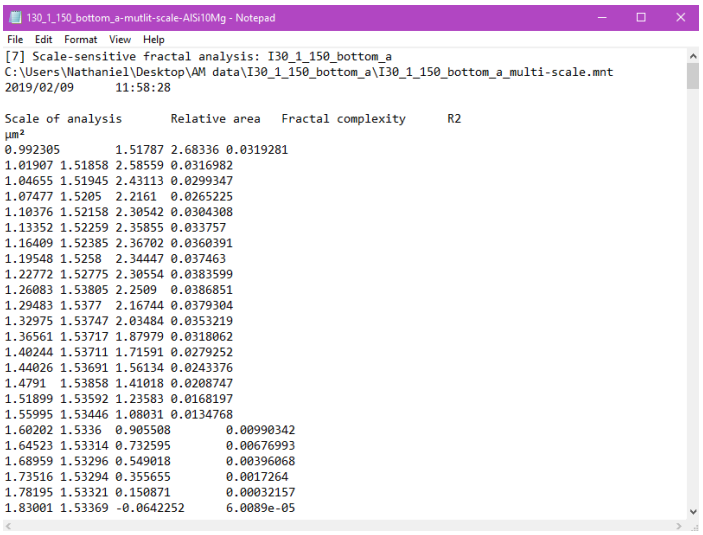


i. Selecting ‘Open’ will display a window from which multiple multiscale area analysis files can be opened from MountainsMap (text files) and Sfrax (Excel files). Images of example files below

Example file from Sfrax



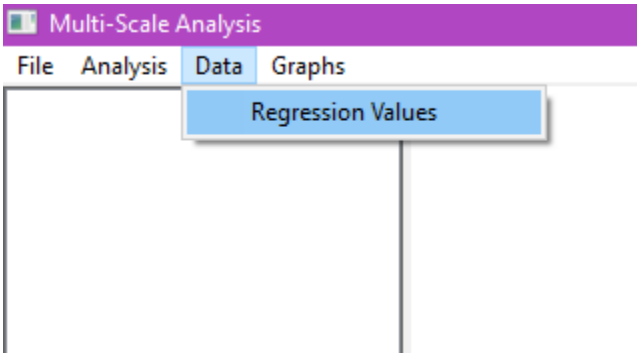
Example file from Mountains Map



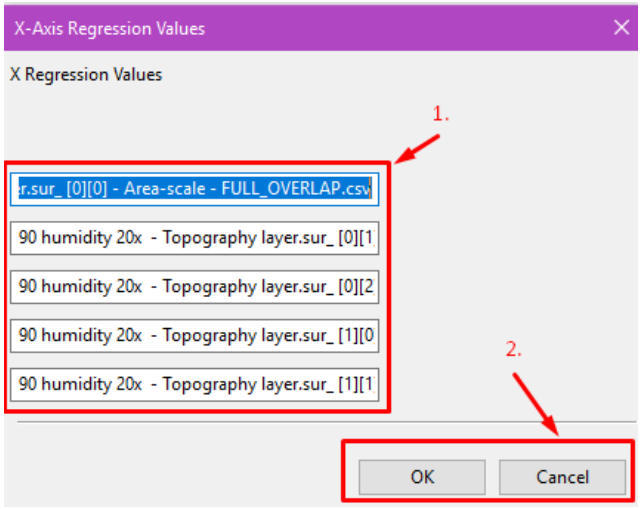
ii. Selecting ‘About’ will display a window which provides links to the source code.

iii. Selecting ‘Exit’ will close the software.

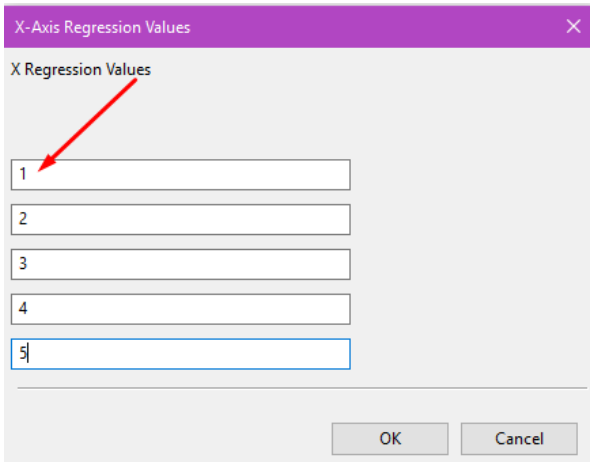
b. Data – 1 option in the drop-down menu



i. Selecting 'Regression Values' will display a window for inputting values.



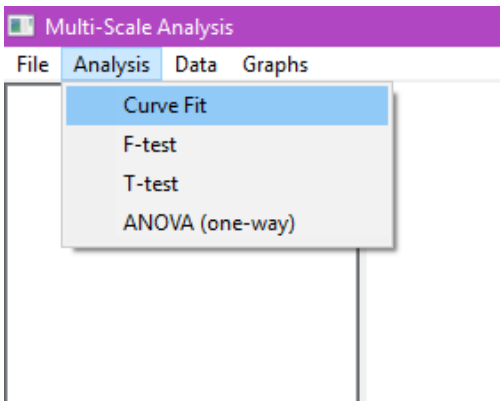
1. For each file that is opened (in this example 5 files from Sfrax were opened) a box will appear with the name of the file in it. In order to perform the regression analysis, numerical values for



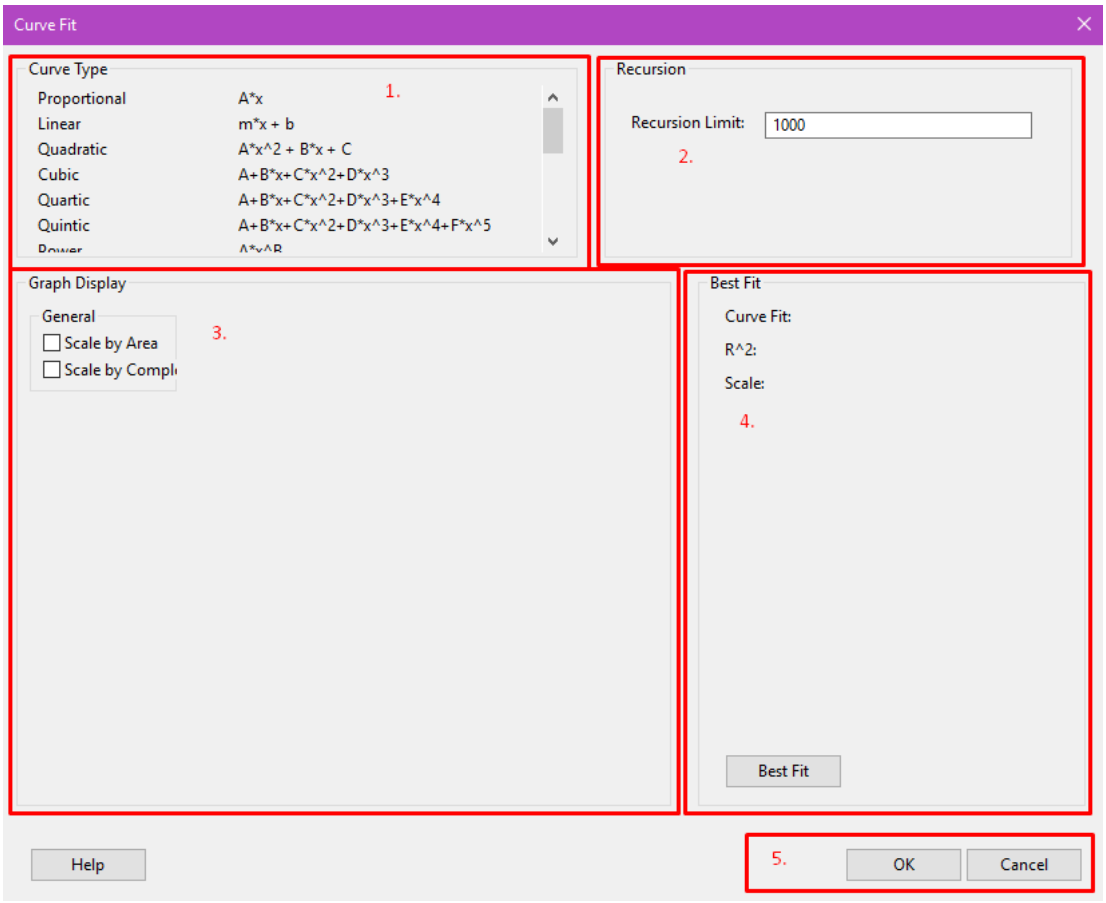
parameters associated with each multiscale analysis file must be entered. Example below

2. Once all of the values have been entered select ‘OK’. These values must be defined before the curve fit analysis can be performed

3. Analysis
    a. 4 options in the drop-down menu



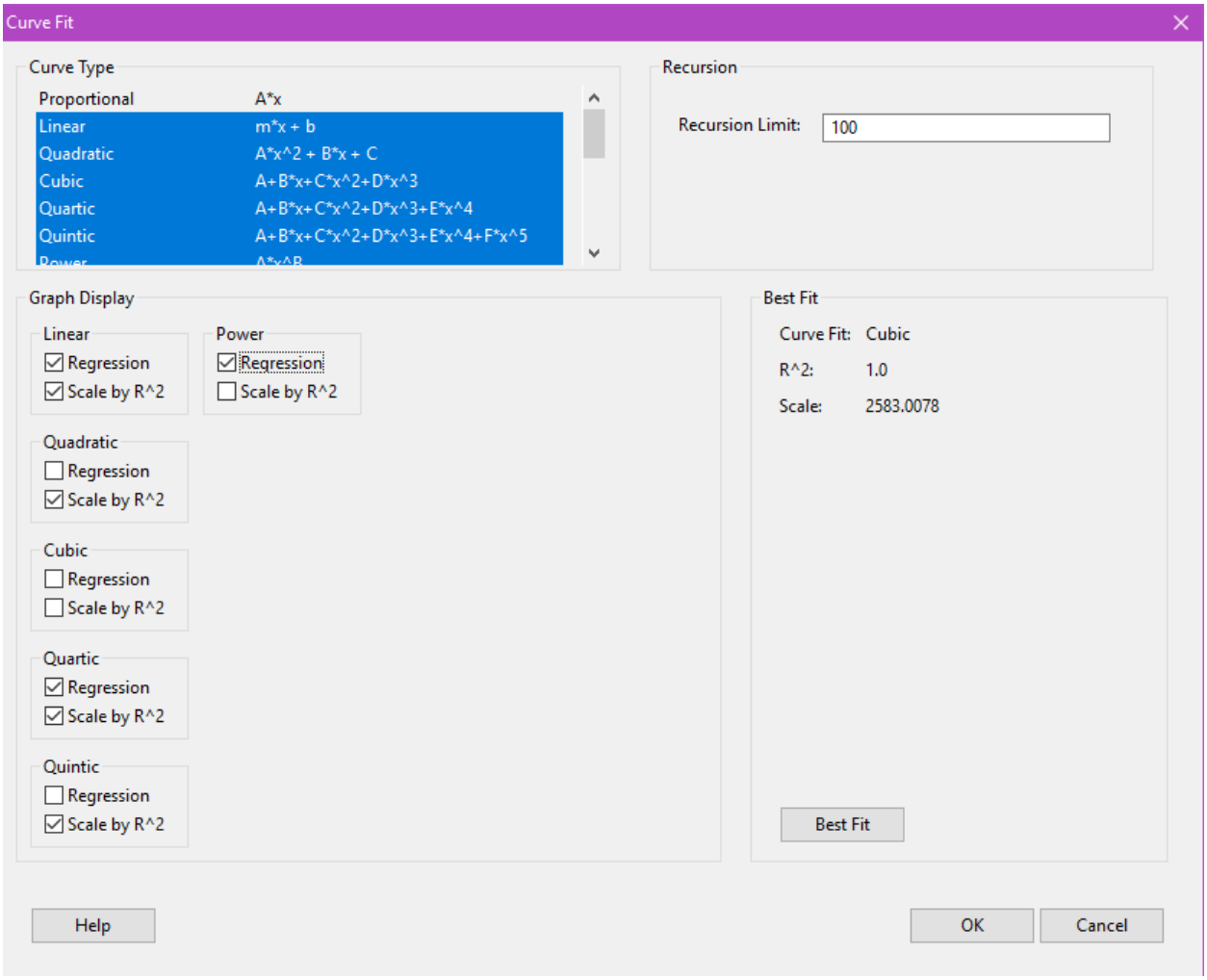
        i. Selecting ‘Curve Fit’ will display a window with options for generating various regression graphs using data from the opened files.



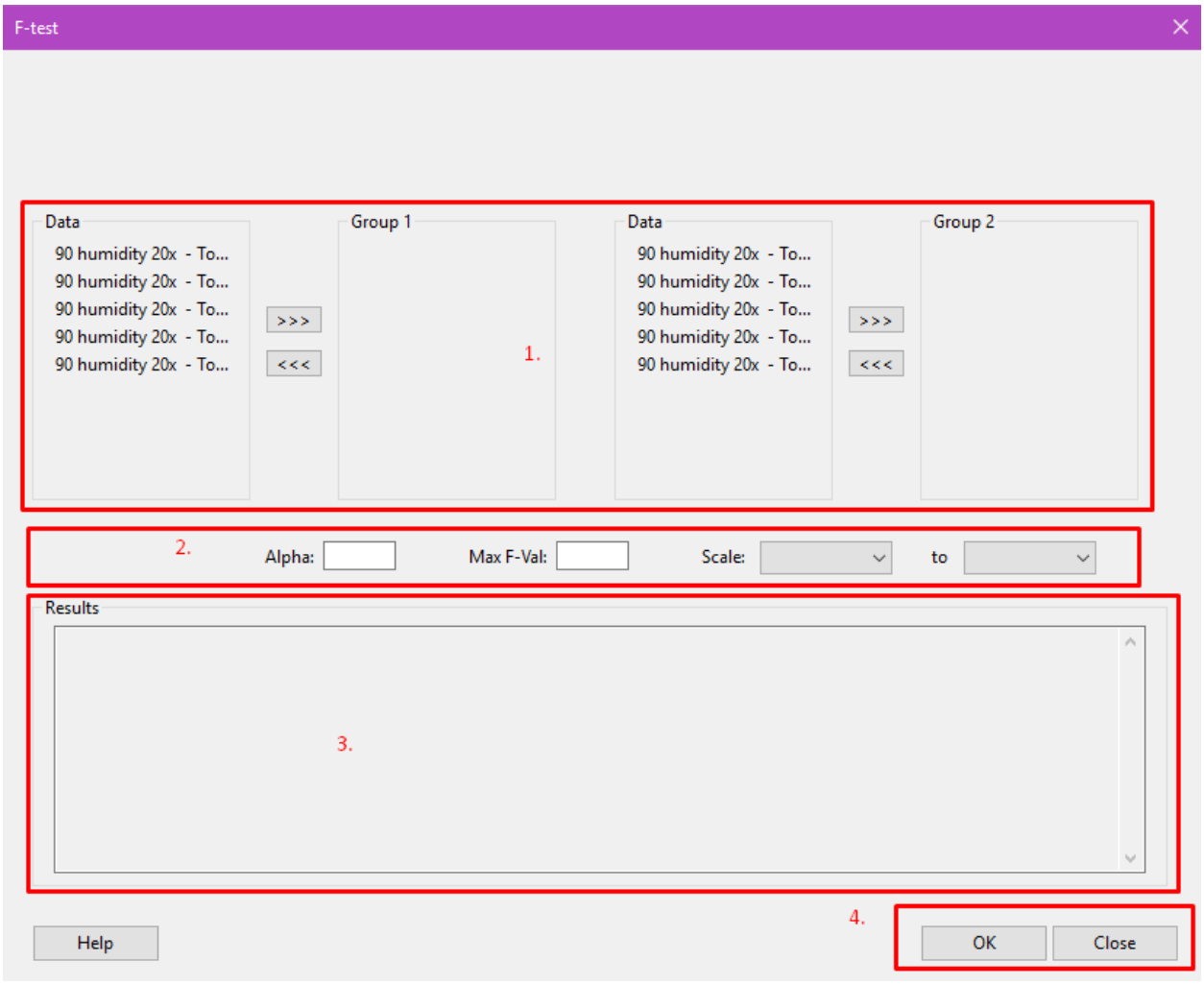
1. 'Curve Type' – select by left-clicking the regression curve types to use in analysis. To select multiple curve types, hold down 'CTRL' while left-clicking. See example below.
2. 'Recursion' – this value is used to determine the recursion limit used when finding the best curve fit for each curve fit. The larger the recursion limit value is the more precise the best curve fit will be. Increasing the recursion limit will also increase the time it takes to generate the regression graphs. See example below.
3. 'Graph Display' – for each curve type selected in section 1 a set of check boxes will appear for the graphs that can currently be generated (see example below):
    a. Regression – at scale with highest R^2 value
    b. R^2 by Scale
4. 'Best Fit' – clicking the 'Best Fit' button will calculate the R^2 value for each curve type at every scale and returns the curve type and

scale for the largest R^2 value. The R^2 calculations will utilize the recursion limit value from section 2. See example below.

5. Once the desired graphs have been checked in section 3 select 'OK' to generate the selected graphs. See example below.



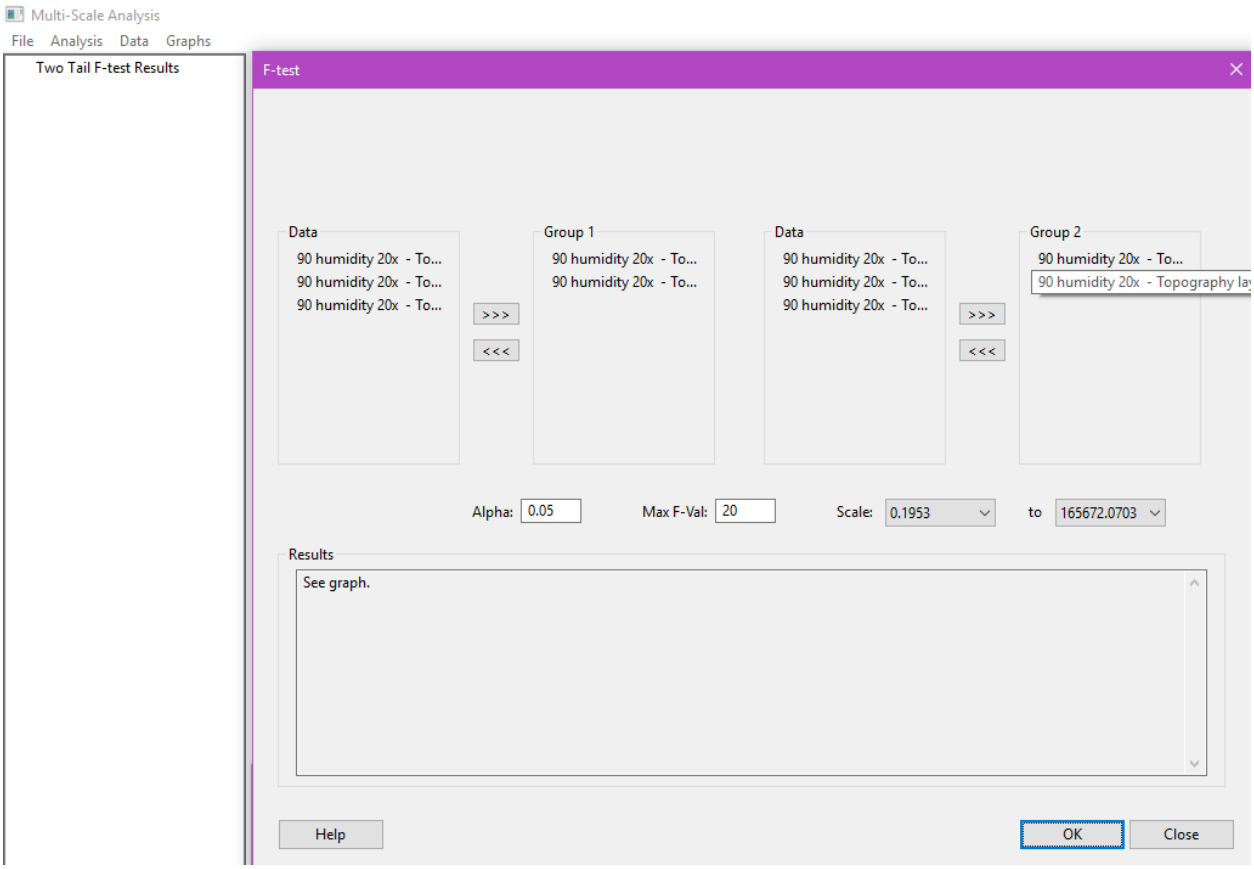
ii. Selecting ‘F-test’ will display a window with options for performing the F statistical test.



1. Group Selection – is where you can select which sets of data to compare using the F-test. The 2 ‘Data’ groups are duplicates of each other and contain the names of the data files you can select from the group. You can click on a data set in the ‘Data’ group or shift + click to select multiple sets. Then use the buttons between the ‘Data’ and numbered group to move the data sets between the ‘Data’ group and numbered group. All of the data sets in ‘Group 1’ will then be compared to all of the data sets in ‘Group 2’. The number of data sets in each group must be equal to perform the F-test. If there is only 1 data set in each group, the F-

test will compare the relative areas at all scales. If there is more than 1 data set in each group, the F-test will be performed at each scale comparing just the groups of relative areas at those scales.

2. F-test Parameters – this is where parameters can be changed for the F-test
    a. Alpha – input value in range from 0-1. The statistical confidence of the test is 1 – alpha.
    b. Max F-Val – input value to limit the max f-value. The more dissimilar the data sets are the f-value will be larger than 1. Currently, for all f-values larger than the set value, the f-value at that scale will be set to 0. Only applicable for more than one data set in each group.
    c. Scale – only applicable for more than one data set in each group. Select the range to perform the multiscale F-test on.
3. Results – the results of the F-test are displayed here. For multiscale F-tests a graph will be generated.
4. Once prepared to perform the F-test select ‘OK’ or ‘Close’ to exit the window. See example below.

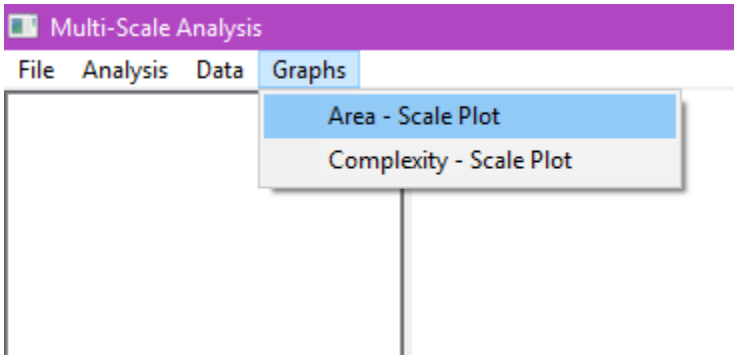


iii. Selecting ‘T-test’ will display a window with options for performing the T statistical test.
    1. See ‘F-test’. Note: a maximum T-value cannot yet be set by the user.
iv. Selecting ‘ANOVA (one-way)’ will display a window with options for performing the ANOVA test.
    1. See ‘F-test’. Note: there is no option for a maximum value.

4. Graphs
    a. Refer to section 2 ‘Getting Started’ and section 3 ‘Analysis’ to learn how to generate curve fitting graphs and statistical analysis graphs.
        i. Regression Graph
            1. Hovering over the data points with the mouse will show the x and y coordinates of the data point in the bottom left hand corner.
        ii. R^2 by Scale Graph
            1. See 1. In regression graphs
            2. Double left clicking on a data points will show the regression graph at that scale for the curve type of the R^2 by Scale Graph.

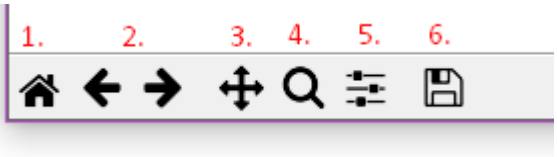
iii. F-test Multiscale Results
    1. Double left clicking on a data point will show statistical information for the F-test at that scale
iv. T-test Multiscale Results
    1. Double left clicking on a data point will show statistical information for the T-test at that scale. **Note: this is to be implemented.**
v. ANOVA Multiscale Results
    1. Double left clicking on a data point will show statistical information for the ANOVA test at that scale.
    2. A horizontal line is plotted which shows the Mean Square Ratio (MSR) for the ANOVA test given the size of the groups and the confidence value.
vi. Scale by Complexity Graph
    1. To generate, select 'Graphs' in the main window menu bar and click on 'Complexity – Scale Plot' to generate.

vii. Scale by Area Graph
    1. To generate, select 'Graphs' in the main window menu bar and click on 'Area – Scale Plot' to generate.



b. For all graphs if you hover your mouse over a data point, the x,y coordinates for that point will be displayed in the lower left corner of the plot.

c. Graph toolbar



i. Each graph has the toolbar pictured above on the bottom left hand side of the screen
    1. 'Home Button' – selecting this will return to the initial graph view
    2. 'Undo / Redo Buttons' – selecting either of these buttons will undo or redo changes made to the graph
    3. 'Pan Button'
        a. Left click and drag – allows movement around the graph
        b. Right click and drag – scales the axes in the direction of movement. Ex, horizontally right increases the x-axis scale.
    4. 'Zoom Button'
        a. Left click and draw rectangle – zoom in to view.
        b. Right click and draw rectangle – zoom out of view.
    5. 'Axes Parameters Button' – sliders to adjust the subplot parameters
    6. 'Save Button' – clicking will show a window to save the graph. Multiple file options included.

5. Graph Options
    a. From the graph menu select either:
        i. 'File' – options for saving the image
            1. 'Close' – closes the current graph window.
            2. 'Save' -- clicking will show a window to save the graph. Multiple file options included.
        ii. 'Graph' – options for changing the graph
            1. 'Label' – add x-axis, y-axis, and title labels to the graph.
            2. 'Legend' – select the location of the graph legend and type in labels. Currently, legend labels must be typed.
            3. 'Symbol' – select the symbol shape and size for the data points.
            4. 'Annotate'
                a. Regression Graph – will display a box containing the R^2 value and scale at which the regression occurs. Hold down left click on the box to drag and reposition it.

b. Other Graphs – annotate will display the x, y coordinate of each data point near it. **NOT RECOMMENDED rather hover over the data point.**

5. 'Grid' – enable and disable a background grid on the graph. Options for color and grid line style.
6. 'Graph Color' – color options available for each element plotted on the graph. Note: not yet implement for complexity and area by scale graphs.

iii. 'Statistics' – **Currently for ANOVA graph results only.**

1. 'Confidence' – type in the confidence value, 0 -1, for the minimum mean square ratio.

6. Errors – **Note: not all errors are logged in the main window yet. This will be implemented soon and the error list below will be updated.**
    a. Error messages appear in the bottom section of the interface. Some messages will have two parts.
        i. What part of the program encountered the error, example: 'Linear:'. This would indicate that the program was performing a calculation involving linear regression
        ii. The error that was encountered, a list of which are below. If an error is encountered that is not listed below contact the developers at _____.
            1. Covariance of the parameters could not be estimated
                a. This error occurs when an optimal relationship cannot be determined for the selected curve fit type. Increasing the recursion limit (see section 3) can occasionally prevent this

error from occurring. When this does occur the R^2 value at that scale is set to be 0 by default.

2. *"curve type"*_fit() argument after * must be an iterable, not int
    a. This error occurs when numerical values are not specified for the x-axis regression values. See section 1b for more details.
3. Improper input: N=*"X"* must not exceed M=*"Y"*
    a. This error occurs for a specific curve type when there are not enough data points to perform a regression calculation. For example, at least 4 data points are needed to find an equation for quadratic regression and at least 6 for quantic regression. X and Y will be integer numbers
4. Optimal parameters not found: Number of calls to function has reached maxfev = *"X"*.
    a. This error occurs when the optimal regression equation for the curve fit cannot be found before reaching the recursion limit. Increasing the recursion limit (see section 3) can prevent this error from occurring. X is the current recursion limit.
5. invalid literal for int() with base 10: *"String"*
    a. This error occurs when anything, but a number is typed into the recursion limit textbox (see section 3). The String will be what is typed into the textbox that causes this error.