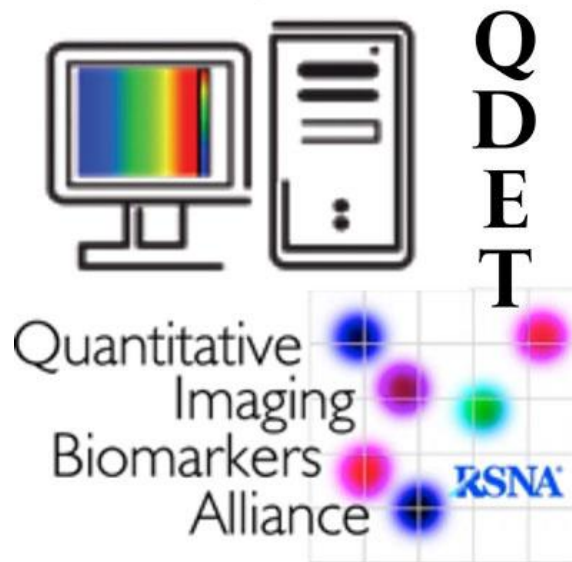


Manual of QIBA-PDF-Evaluation tool

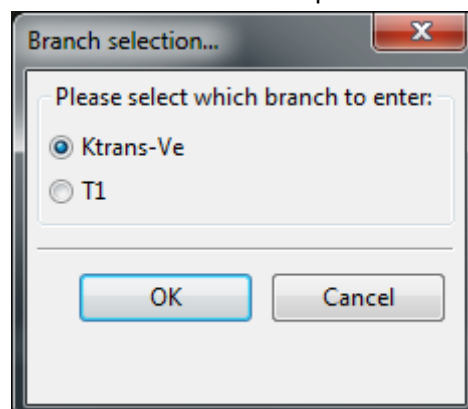
This manual will shortly introduce how to maneuver the application.

- If you are going to run the source code, please download and install the necessary packages. You will find the relevant information in file 'README.md'. To launch the application in Python, type 'python QIBA_evaluate_tool.py KV' or 'python QIBA_evaluate_tool.py T1' to enter the corresponding branch. If the second parameter is not given, i.e. 'python QIBA_evaluate_tool.py', the application will show one dialog window for selecting which branch to enter.
- The stand-alone installer for Windows is now available. After installing it on the computer, you will have the same using experience with running the application as running the source code in Python.
- Run QIBA evaluate tool. The slash window will show and last for about 2 seconds.



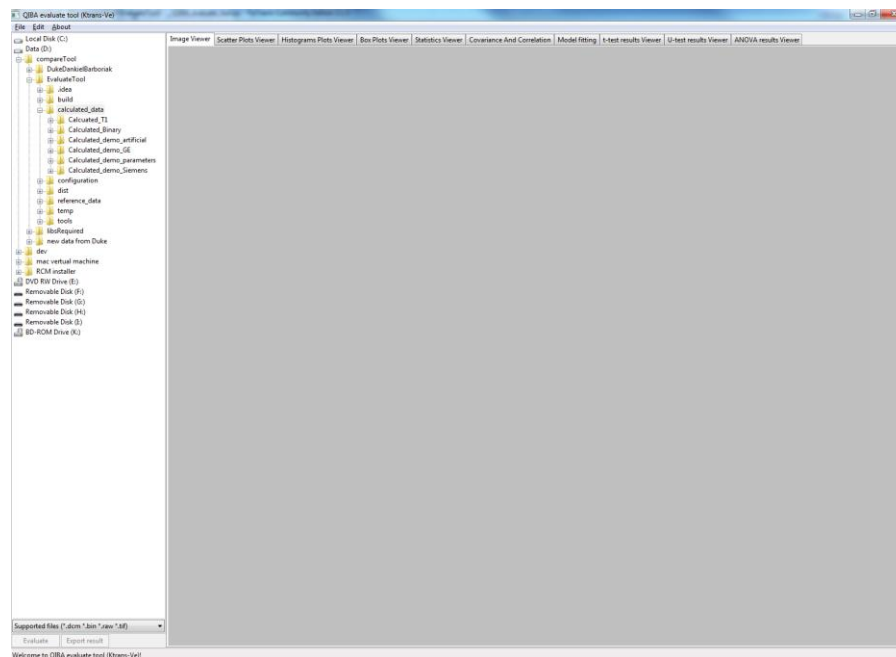
(Welcome splash screen)

- There are two branches of application available, being 'QIBA evaluate tool (Ktrans-Ve)' and 'QIBA evaluate tool (T1)' respectively. The selection dialog of which branch to enter will pop up right after the dismissing of the welcome splash screen (shown above). As the interface and the basic operations are rather similar for 'Ktrans-Ve' and 'T1' branches, some of the instructions will be using 'Ktrans-Ve' branch as examples.



(Branch selection dialog)

- The interface on initialization should look like:

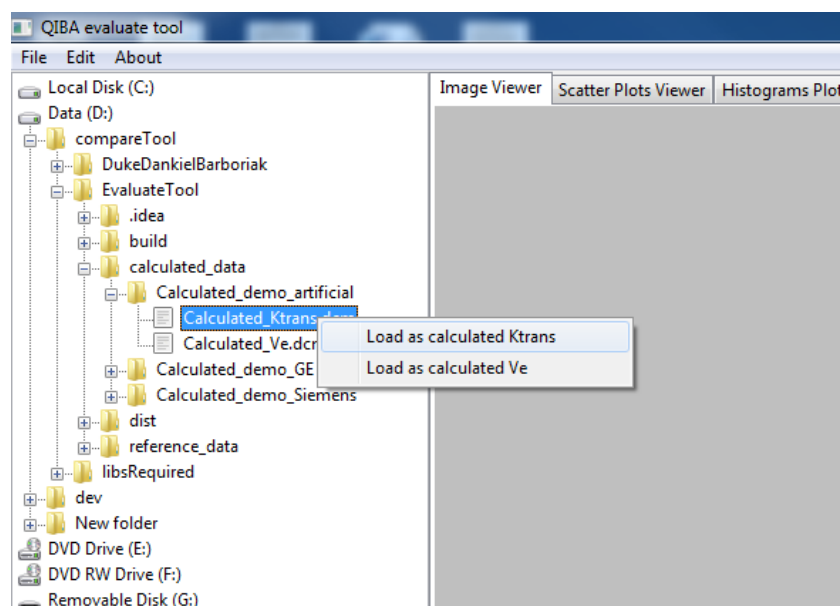


(Initial interface)

The left side of the window is the tree list of the directories and files. By default, the directory of the application will be selected. Later you could load calculated files from the tree list.

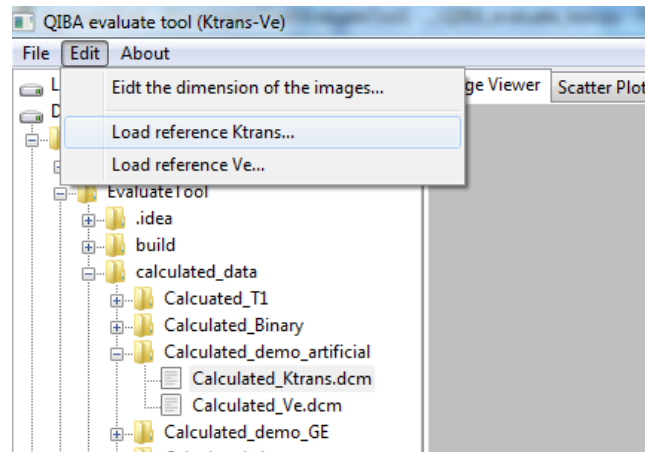
- In order to import the calculated data, please left click to select the DICOM file that you want to import. Then right click on it, resulting in a popup menu with two options: “Load as calculated Ktrans” and “Load as calculated Ve”. Left click to choose the corresponding option in the popup menu to load the file.

By default, the tree list will open the folder “calculated_data”. The sub folders contain data for demonstrating. When you need to test your own data, you can put the data under the folder ‘calculated_data’, so that the data can be handily imported.

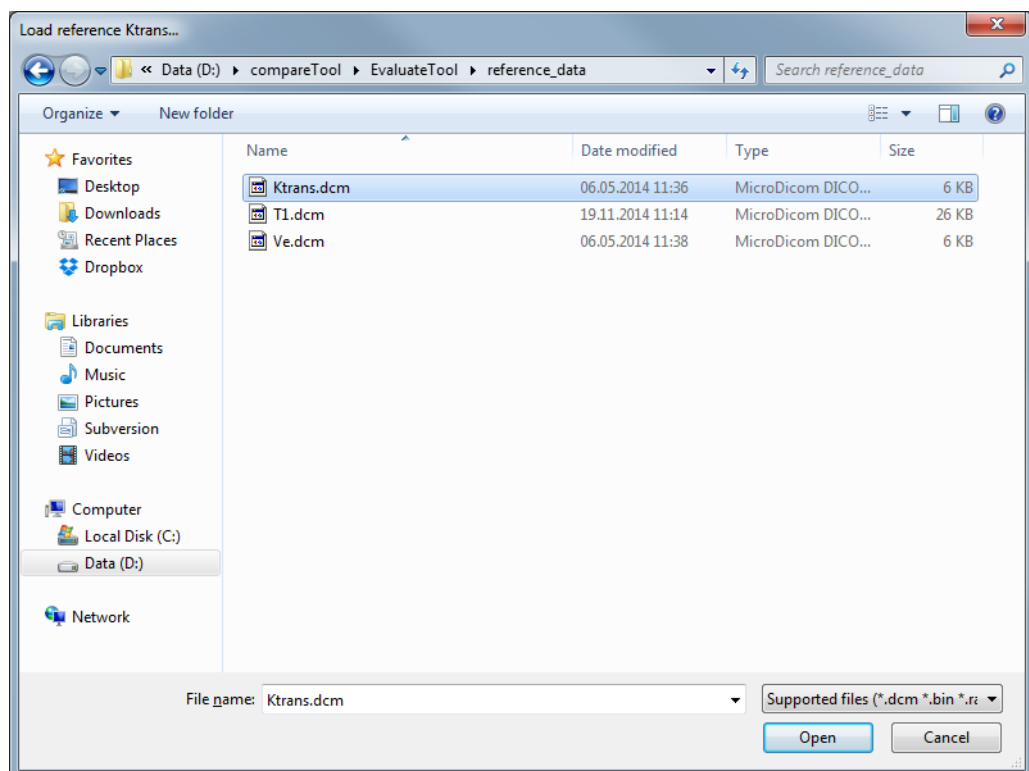


(Loading calculated files)

- By default, the reference files are loaded on launching the application. (The reference files lie in the folder “reference_data”.) In case you want to change the reference files, please click on the menu bar “Edit -> Load Ktrans reference parameter map...” or “Edit -> Load Ve reference parameter map...” or “Edit -> Load T1 reference parameter map...”, depending on which branch you entered. In the new file selection dialog, you can choose the file that you want to load as reference data. The supported file types including DICOM, binary and TIFF.

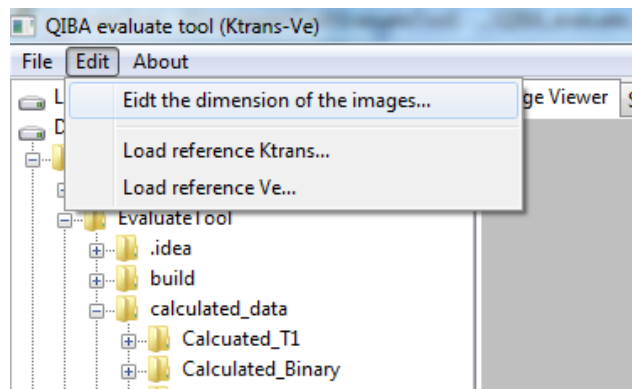


(Load reference files)

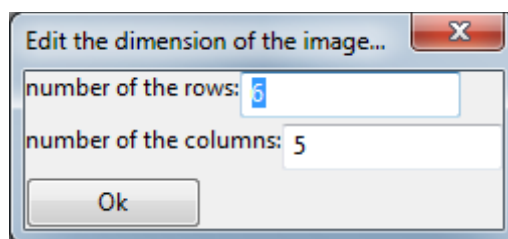


(Reference file selection dialog)

- In case the image dimension needs to be set manually, you could click on the “Edit the dimension of the images...” from the edit manu. An eidtable dialog will pop up consequently.

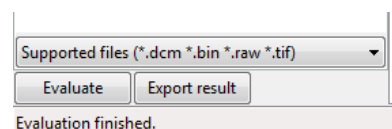


(Option of editing image dimensions)



(Image dimension editing dialog)

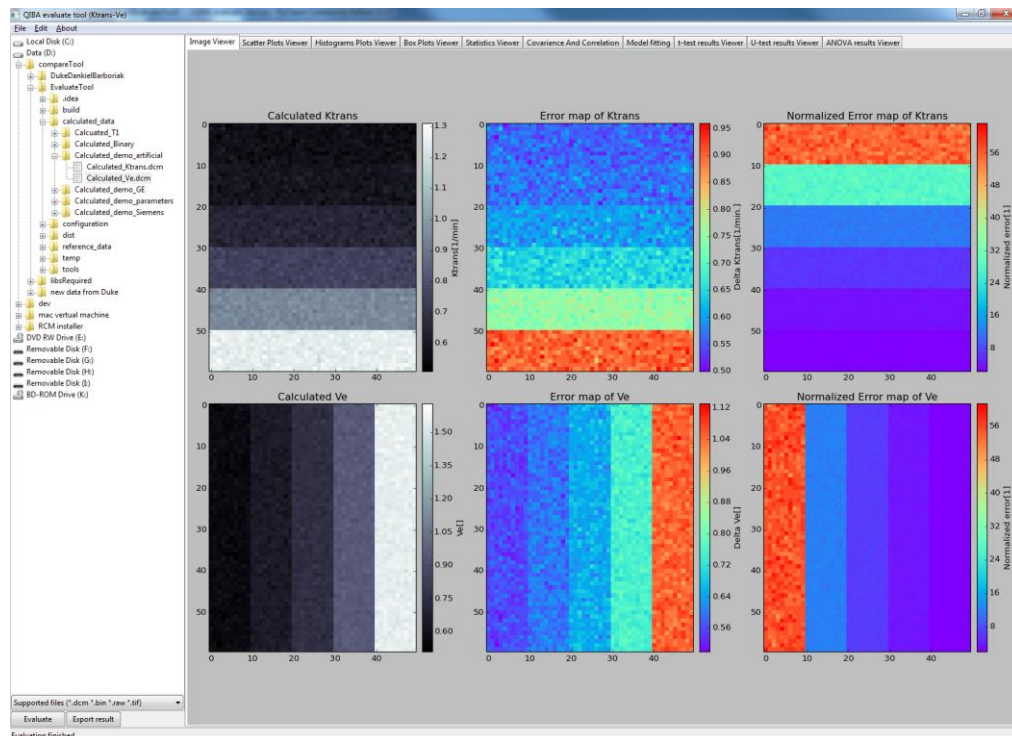
- Once the calculated data maps are loaded, the evaluation will start by clicking on the “Evaluate” button at the bottom of the left column of the window. The status bar will show the “Evaluating...”. When the status bar shows the message “Evaluation finished.”, the evaluation results could be viewed from the tabs on the right side of the window.



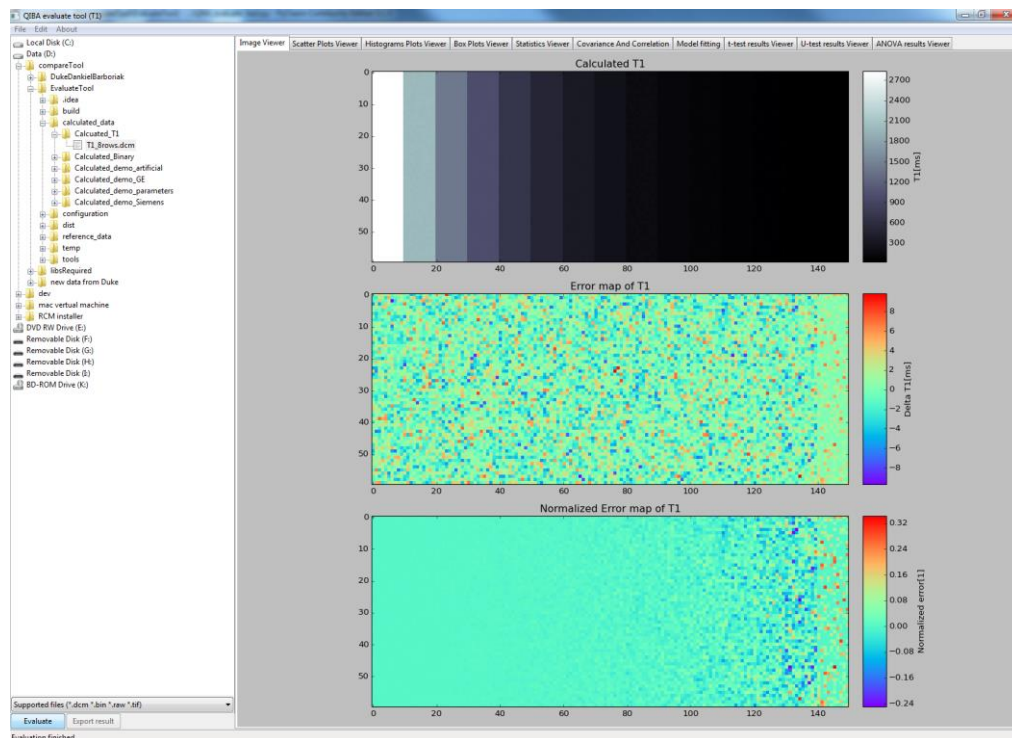
(Status bar notation)

- The tab “Image Viewer” shows the preview of the calculate data maps, the error compared to the reference files, and the normalized error, in each column from the left side to the right side. There are color bars besides the figures, which you can refer to read the value range and value mapping. The figures arrangement is different between the Ktrans-Ve branch and the T1 branch, as they have different number of figures to show. The description bellow will be for Ktrans-Ve branch, which is analogous to that of T1 branch, expect that the row of figures is transposed to a column.
The first column shows the calculated Ktrans and Ve in black and white. You can have a general impression of the value distribution according to the changing of the parameters. Generally the brighter the pixel is, the higher the calculated value is.
The Second column shows the error map between calculated and reference data. Each pixel is the result of corresponding pixel in calculated data being subtracted with that in the reference data. Generally the more the color approaches to the red direction, the larger the error is.

The third column shows the normalized error. This is out of the consideration that the error could be related with the original value itself. Therefore normalized error may give a more uniformed standard of the error level. Each pixel's value comes from the division of the error by the reference pixel value. Similarly as the error map, the more the color approaches to the red direction, the larger the normalized error is.



(Figures for Ktrans-Ve branch)



(Figures for T1 branch)

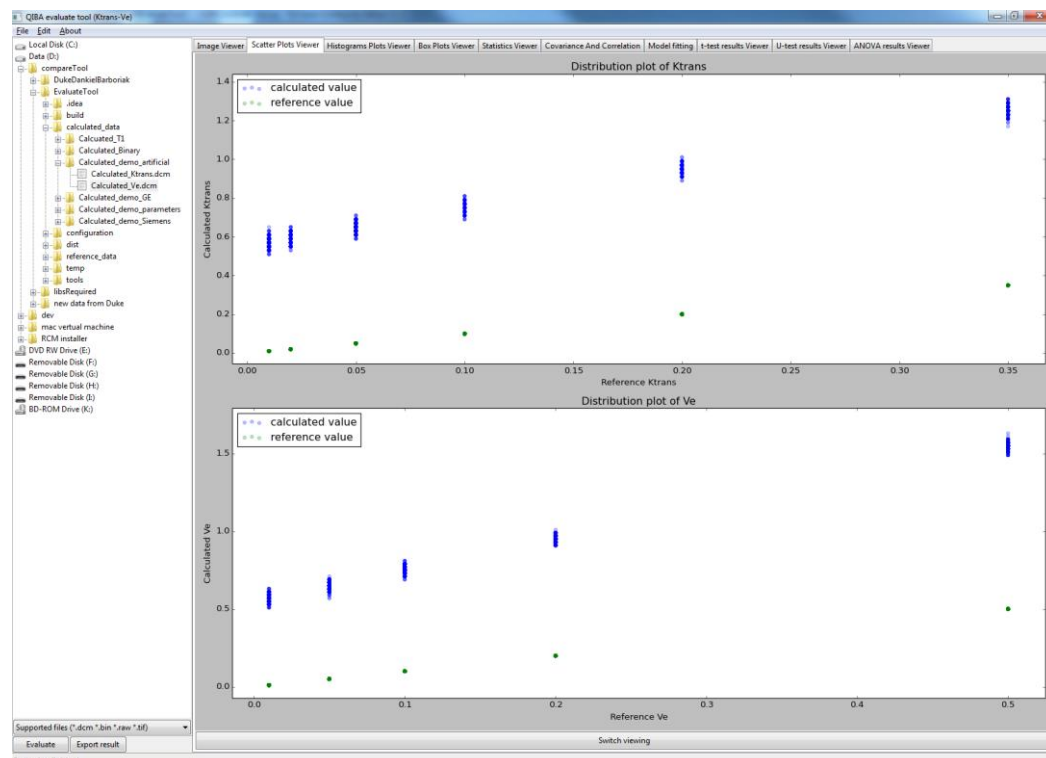
- The tab “Scatter Plots Viewer” shows the scatter plots of the calculated and the reference maps. As described in the legend, the blue and green dots denote pixels from the calculated and reference respectively. The description will be for Ktrans-Ve branch, whilst the condition for T1 branch is analogous.

Considering the reference Ktrans (or Ve) has discrete values, being a constant for each row (or column) in the data map, the dots of corresponding row (or column) will be plotted aligning to that x-axis.

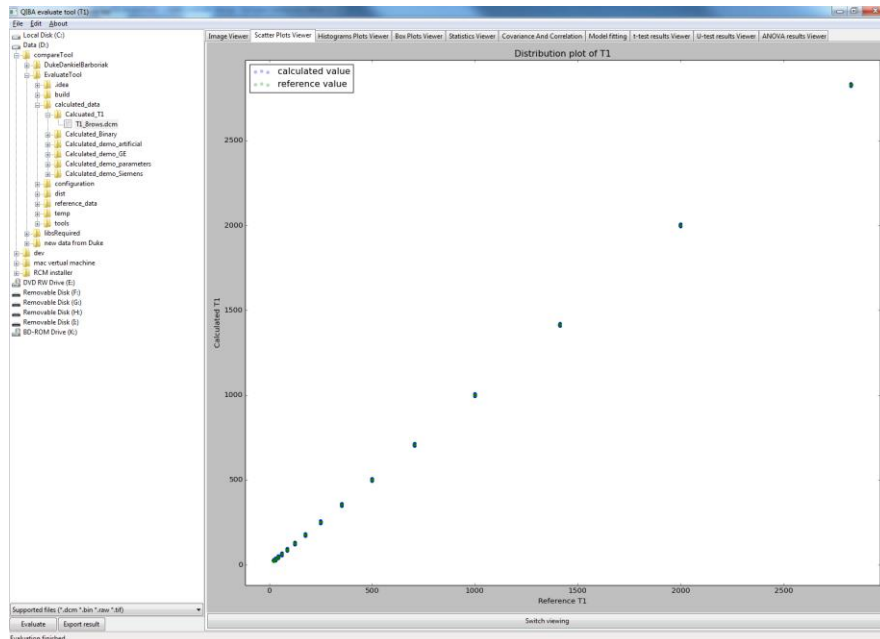
For the reference data, the pixel values in one row (for Ktrans) or column (for Ve) share the same constant value. Therefore in the scatter plot it shows that all green dots of a row (or column) overlap to each other. For the calculated data, as they share the same parameter, the blue dots align to the same x-axis. But they may scatter vertically, showing there’s variance of the value in a row (or column).

From these plots you can see the trend of the values, which offer some information of which model (e.g. linear or logarithmic) the calculated parameter may fit. For example, with the artificial calculated data which were generated from the reference data by adding Gaussian noise, scaling by two and adding 0.5, it can be easily read from the plots that the calculated data follow the linear model, and have scaling factor and extra bias value.

The button ‘Switch viewing’ at the bottom of the viewer offers the possibility to view the data at difference scale. In case the calculated data has a large range of values, the slope of the data may become less obvious, while the users can have a clear view of the data distribution. In order to have a better view of the calculated data and the reference data in terms of slope, switching the viewing scale may be plausible.

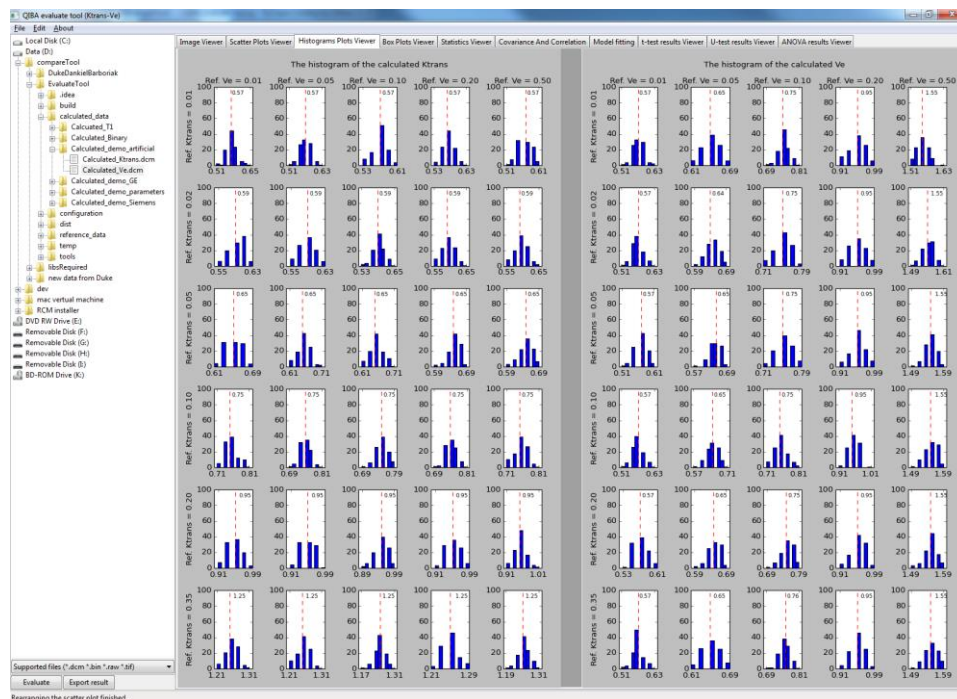


(Figures for Ktrans-Ve branch)

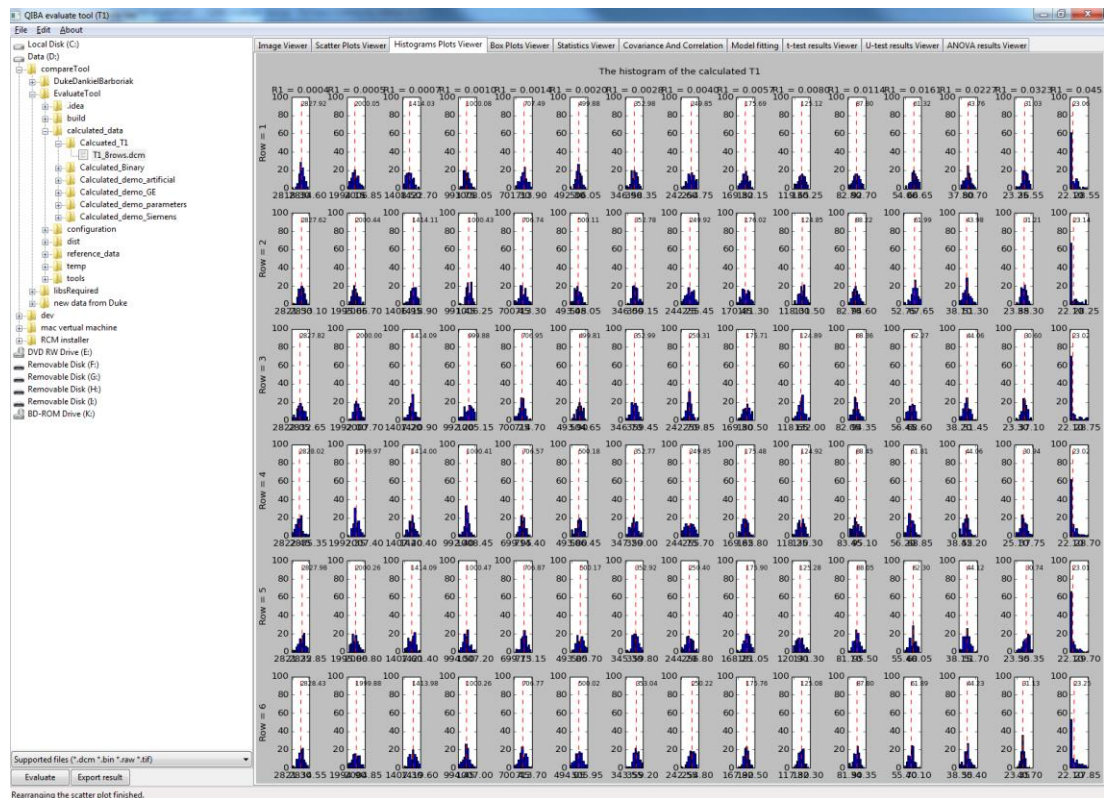


(Figure for T1 branch)

- The tab “Histograms Plots Viewer” shows the histogram of each patch from calculated Ktrans and Ve or T1, depending on which branch you entered, so that you can have a look at the distribution of the pixels in each patch of difference parameter combination. All histograms have the uniformed y-axis limits, so that the comparison among different patched is easier. The minimum and maximum values of a patch are denoted on the x-axis for reference.



(Histograms for Ktrans-Ve branch)

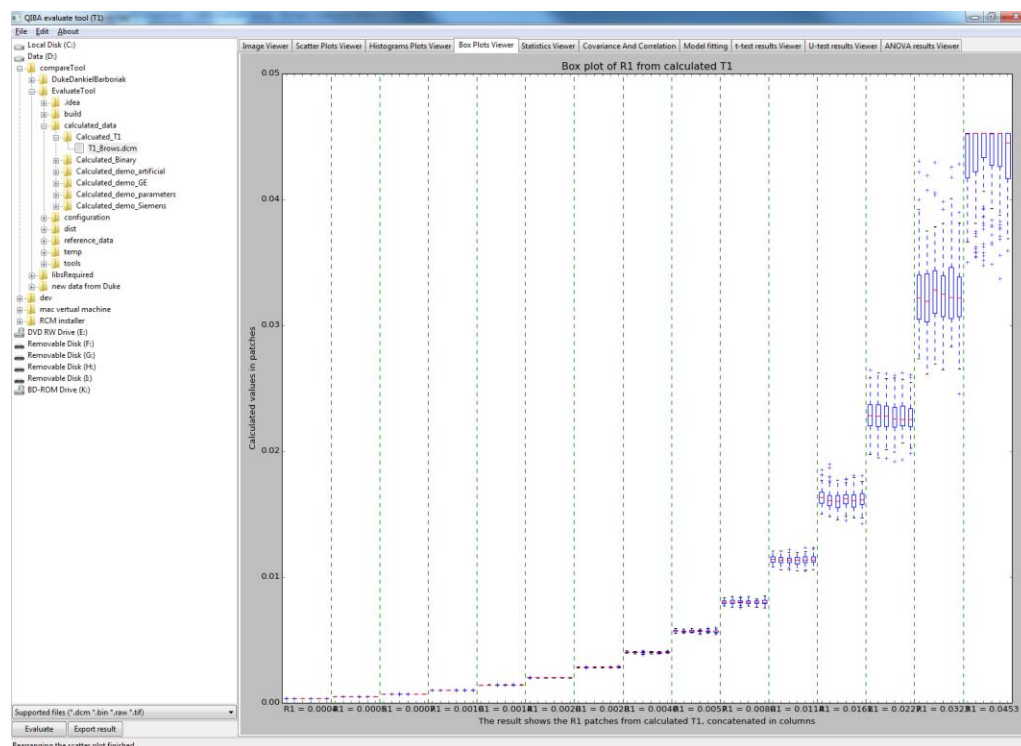
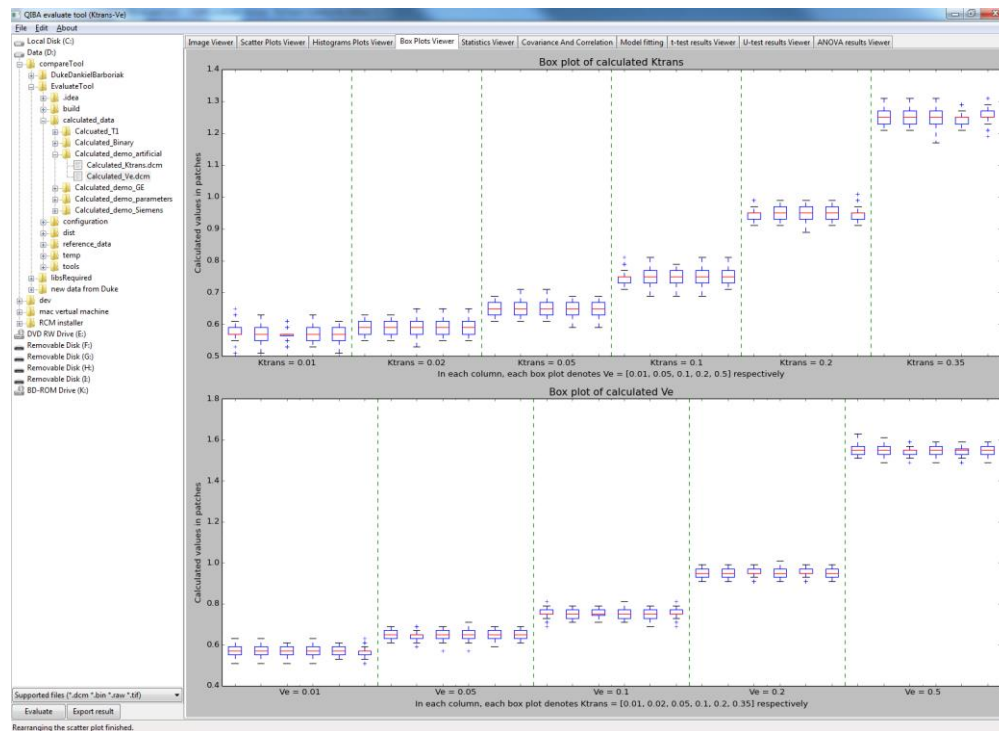


(Histograms for T1 branch)

- The tab “Box Plots Viewer” shows the box plots of each patch in the calculated Ktrans and Ve or T1, depending on which branch you entered. It offers another view of the distribution of the patches with different parameter combinations.

The vertical dash lines are used to separate the rows (or columns), as each box plot is responsible for one patch. From these plots you could see (roughly) the statistics of each patch, like the mean value, the 1st and 3rd quartile, the minimum and maximum value. The more precise value of those statistics could be found in the tab “Result in HTML viewer”.

Note: for the T1 branch, the scatter plot shows the value of R1, which is calculated as $R1 = 1/T1$



- The tab “Statistics Viewer” shows the statistics in HTML form. Unlike the tabs introduced before, this tab shows the results in html form, i.e. without special visualization method. From these tables you can read the value more precisely. The description of this tab is for Ktrans-Ve branch, while the condition in T1 branch is analogous. (Therefore the descriptions under are only for the Ktrans-Ve branch.)

There are two tables for Ktrans and Ve respectively, i.e. “the mean and the standard value” and “the median, 1st and 3rd quartile, min. max. value”. From the table, you could read the statistics from the corresponding position regarding to different reference Ktrans and Ve.

The statistics analysis of each patch in calculated Ktrans:

the mean and standard deviation value

	Ref. Ve = 0.01	Ref. Ve = 0.05	Ref. Ve = 0.10	Ref. Ve = 0.20	Ref. Ve = 0.50
Ref. Ktrans = 0.01	mean = 0.57 SR = 0.02	mean = 0.57 SR = 0.02	mean = 0.57 SR = 0.02	mean = 0.57 SR = 0.02	mean = 0.57 SR = 0.02
Ref. Ktrans = 0.02	mean = 0.59 SR = 0.02	mean = 0.59 SR = 0.02	mean = 0.59 SR = 0.02	mean = 0.59 SR = 0.02	mean = 0.59 SR = 0.02
Ref. Ktrans = 0.05	mean = 0.65 SR = 0.02	mean = 0.65 SR = 0.02	mean = 0.65 SR = 0.02	mean = 0.65 SR = 0.02	mean = 0.65 SR = 0.02
Ref. Ktrans = 0.10	mean = 0.75 SR = 0.02	mean = 0.75 SR = 0.02	mean = 0.75 SR = 0.02	mean = 0.75 SR = 0.02	mean = 0.75 SR = 0.02
Ref. Ktrans = 0.20	mean = 0.95 SR = 0.02	mean = 0.95 SR = 0.02	mean = 0.95 SR = 0.02	mean = 0.95 SR = 0.02	mean = 0.95 SR = 0.02
Ref. Ktrans = 0.35	mean = 1.25 SR = 0.02	mean = 1.25 SR = 0.02	mean = 1.25 SR = 0.02	mean = 1.25 SR = 0.02	mean = 1.25 SR = 0.02

the median, 1st and 3rd quartile, min. and max. values

	Ref. Ve = 0.01	Ref. Ve = 0.05	Ref. Ve = 0.10	Ref. Ve = 0.20	Ref. Ve = 0.50
Ref. Ktrans = 0.01	min. = 0.51 1st quartile = 0.57 median = 0.57 3rd quartile = 0.59 max. = 0.65	min. = 0.51 1st quartile = 0.55 median = 0.57 3rd quartile = 0.59 max. = 0.63	min. = 0.53 1st quartile = 0.55 median = 0.57 3rd quartile = 0.57 max. = 0.61	min. = 0.53 1st quartile = 0.55 median = 0.57 3rd quartile = 0.59 max. = 0.63	min. = 0.51 1st quartile = 0.55 median = 0.57 3rd quartile = 0.59 max. = 0.65
Ref. Ktrans = 0.02	min. = 0.55 1st quartile = 0.57 median = 0.59 3rd quartile = 0.61 max. = 0.65	min. = 0.55 1st quartile = 0.57 median = 0.59 3rd quartile = 0.61 max. = 0.65	min. = 0.53 1st quartile = 0.57 median = 0.59 3rd quartile = 0.61 max. = 0.65	min. = 0.55 1st quartile = 0.57 median = 0.59 3rd quartile = 0.61 max. = 0.65	min. = 0.55 1st quartile = 0.57 median = 0.59 3rd quartile = 0.61 max. = 0.65
Ref. Ktrans = 0.05	min. = 0.61 1st quartile = 0.63 median = 0.65 3rd quartile = 0.67 max. = 0.71	min. = 0.61 1st quartile = 0.63 median = 0.65 3rd quartile = 0.67 max. = 0.71	min. = 0.61 1st quartile = 0.63 median = 0.65 3rd quartile = 0.67 max. = 0.71	min. = 0.59 1st quartile = 0.63 median = 0.65 3rd quartile = 0.67 max. = 0.69	min. = 0.59 1st quartile = 0.63 median = 0.65 3rd quartile = 0.67 max. = 0.69
Ref. Ktrans = 0.10	min. = 0.71 1st quartile = 0.73 median = 0.75 3rd quartile = 0.77 max. = 0.81	min. = 0.69 1st quartile = 0.73 median = 0.75 3rd quartile = 0.77 max. = 0.81	min. = 0.69 1st quartile = 0.73 median = 0.75 3rd quartile = 0.77 max. = 0.79	min. = 0.69 1st quartile = 0.73 median = 0.75 3rd quartile = 0.77 max. = 0.81	min. = 0.71 1st quartile = 0.73 median = 0.75 3rd quartile = 0.77 max. = 0.81
Ref. Ktrans = 0.20	min. = 0.91 1st quartile = 0.93 median = 0.95 3rd quartile = 0.97 max. = 0.99	min. = 0.91 1st quartile = 0.93 median = 0.95 3rd quartile = 0.97 max. = 0.99	min. = 0.89 1st quartile = 0.93 median = 0.95 3rd quartile = 0.97 max. = 0.99	min. = 0.91 1st quartile = 0.93 median = 0.95 3rd quartile = 0.97 max. = 0.99	min. = 0.91 1st quartile = 0.93 median = 0.95 3rd quartile = 0.97 max. = 1.01
Ref. Ktrans = 0.35	min. = 1.21 1st quartile = 1.23 median = 1.25 3rd quartile = 1.27	min. = 1.21 1st quartile = 1.23 median = 1.25 3rd quartile = 1.27	min. = 1.17 1st quartile = 1.23 median = 1.25 3rd quartile = 1.27	min. = 1.21 1st quartile = 1.23 median = 1.25 3rd quartile = 1.25	min. = 1.19 1st quartile = 1.25 median = 1.25 3rd quartile = 1.27

(Statistics tables for Ktrans-Ve branch)

- The tab “covariance and correlation” shows the covariance/correlation of each column/row of calculated Ktrans/ Ve with reference Ktrans/ Ve. For T1 branch, the results show the correlation/ covariance between each row of calculated and reference T1 map. The results are shown in tables respectively. From this tab, you could see the relation between the calculated values and the reference values.

The correlation and covariance of each column in calculated Ktrans map with reference Ktrans map:

Ref. Ve = 0.01	Ref. Ve = 0.05	Ref. Ve = 0.10	Ref. Ve = 0.20	Ref. Ve = 0.50
cov: 0.03 corr: 1.00	cov: 0.03 corr: 1.00	cov: 0.03 corr: 1.00	cov: 0.03 corr: 1.00	cov: 0.03 corr: 1.00

The correlation and covariance of each row in calculated Ktrans map with reference Ve map:

Ref. Ktrans = 0.01	Ref. Ktrans = 0.02	Ref. Ktrans = 0.05	Ref. Ktrans = 0.10	Ref. Ktrans = 0.20	Ref. Ktrans = 0.35
cov: -4.17e-04 corr: -0.81	cov: 1.06e-05 corr: 0.02	cov: -2.37e-04 corr: -0.76	cov: 2.01e-04 corr: 0.81	cov: 1.70e-04 corr: 0.45	cov: 2.94e-04 corr: 0.60

The correlation and covariance of each column in calculated Ve map with reference Ktrans map:

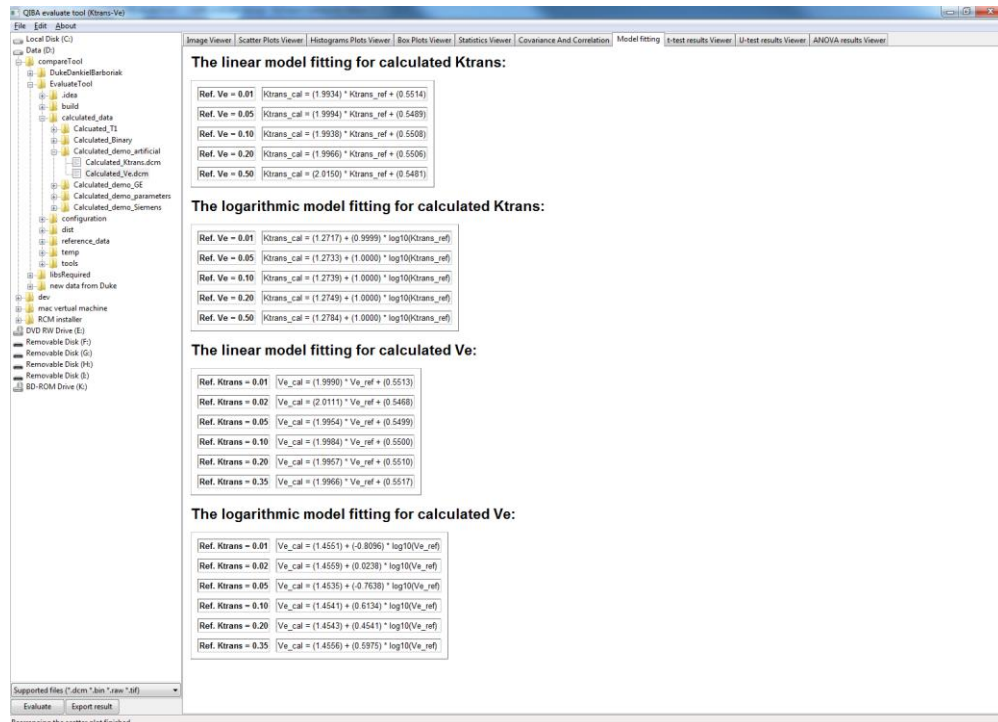
Ref. Ve = 0.01	Ref. Ve = 0.05	Ref. Ve = 0.10	Ref. Ve = 0.20	Ref. Ve = 0.50
cov: 2.33e-06 corr: 0.02	cov: 1.89e-04 corr: 0.53	cov: 1.62e-04 corr: 0.59	cov: 4.53e-05 corr: 0.26	cov: -6.37e-05 corr: -0.22

The correlation and covariance of each row in calculated Ve map with reference Ve map:

Ref. Ktrans = 0.01	Ref. Ktrans = 0.02	Ref. Ktrans = 0.05	Ref. Ktrans = 0.10	Ref. Ktrans = 0.20	Ref. Ktrans = 0.35
cov: 0.08 corr: 1.00	cov: 0.08 corr: 1.00	cov: 0.08 corr: 1.00	cov: 0.08 corr: 1.00	cov: 0.08 corr: 1.00	cov: 0.08 corr: 1.00

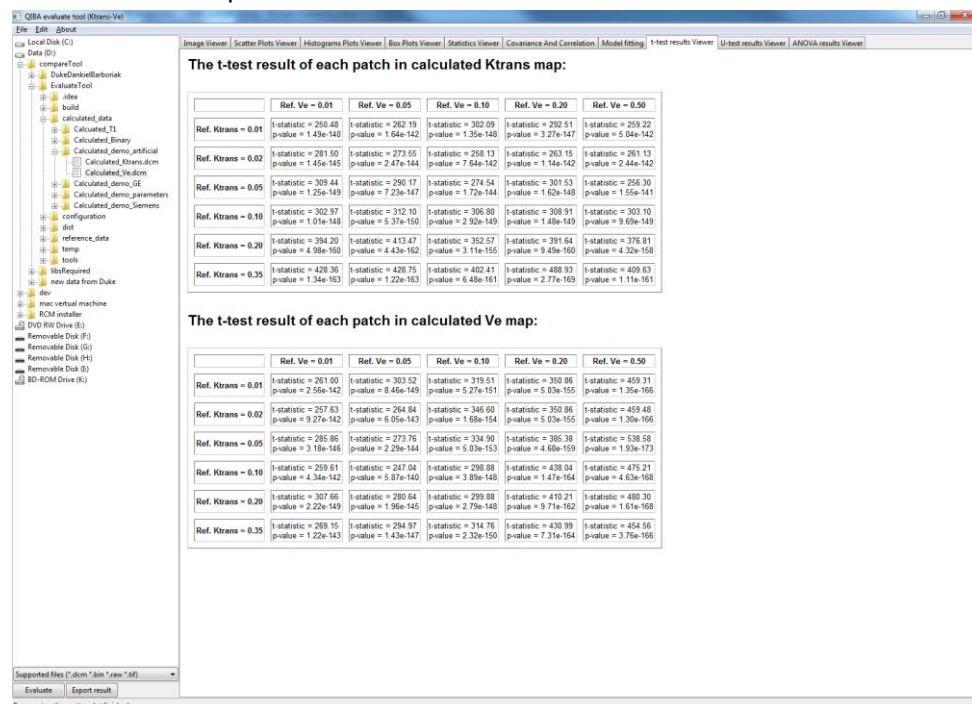
(Correlation/covariance tables for Ktrans-Ve branch)

- The tab “Model Fitting” shows the result of fitting linear model and logarithmic model. The calculation is done between the calculated and reference data fitting the linear and logarithmic models.



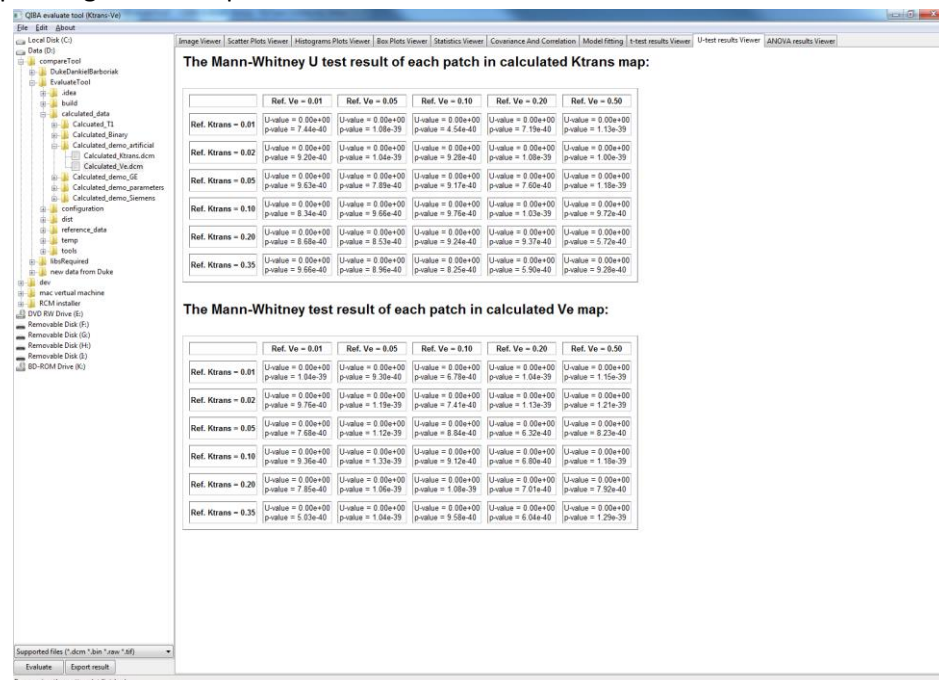
(Model fitting tables for Ktrans-Ve branch)

- The tab “t-test results Viewer” shows the results of t-test on each patch in calculated Ktrans and Ve or T1, depending on which branch you entered. T-test gives a reference of how far the calculated group of values in each patch from the reference values. The tests are done between the calculated patch and the reference value.



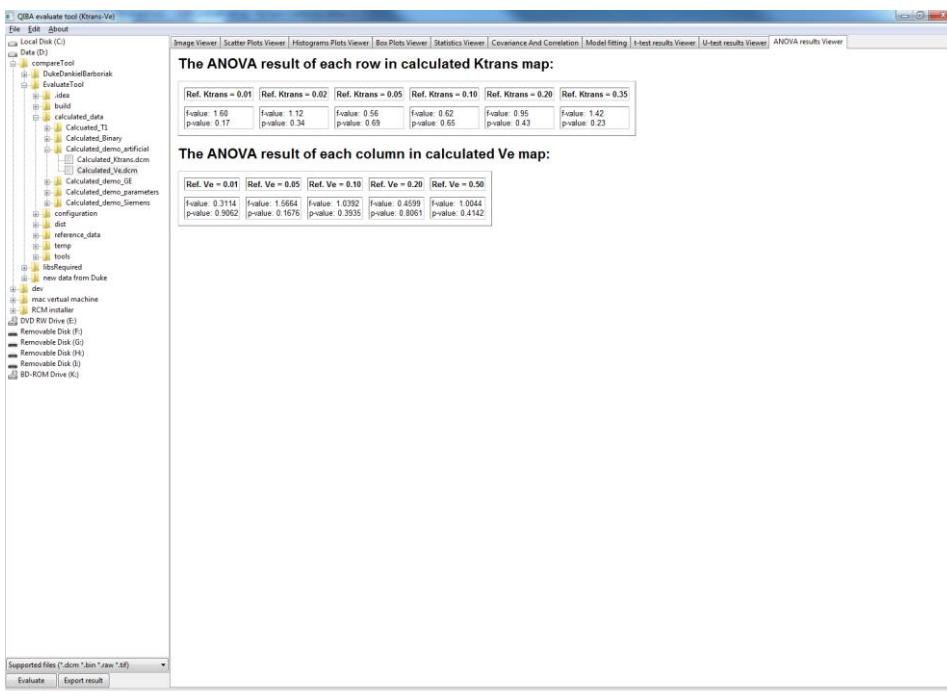
(T-test results tables for Ktrans-Ve branch)

- The tab “U-test results viewer” shows the results of Mann-Whitney U-test of each patch against the reference patch. Mann-Whitney U-test offers a reference that whether two groups of data are the same or not. The tests are done between calculated patch and the corresponding reference patch.



(U-test results tables for Ktrans-Ve branch)

- The tab “ANOVA results viewer” shows the results of ANOVA of each row/column of calculated Ktrans/Ve or T1, depending on which branch you entered, against the reference values.



(ANOVA results tables for Ktrans-Ve table)