LAB #2 SPATIAL and SPECTRAL TRANSFORMATIONS

OVERVIEW

This Lab will provide you an introduction to the multiple spatial and spectral transformations available to you when using ERDAS Imagine. There are large numbers transformations that can be performed on data to enhance various aspects of the images. In this lab you will explore multiple transformations to determine which you think would be best for mapping the objects that are most important to you.

DATA REQUIREMENTS

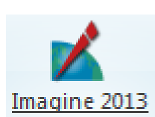
All of the required files can be found in `G:\Share\GEOG_3198_DIPA\Data\Lab_1.`
You will be using the same data that was used in lab number one to run the transformations on different images.

`2001_dc_sub.img`	Subset of a 6-band Landsat 7 ETM+ scene, from August 2, 2001. It shows the metro D.C. area including portions outside of the beltway.
`2001_dc_sub.rrd`	Pyramid layers (Imagine file type) for the 2001 TM scene
`ikonos_dc.img`	An April 1, 2000, IKONOS 4 band multispectral image of a portion of downtown DC.
`ikonos_dc.rrd`	Pyramid layers (Imagine file type) for the 2000 IKONOS scene

PROCEDURES

PART 1 IMAGE DISPLAY and INFORMATION

START IMAGINE
In order to start IMAGINE **Start, Programs, ERDAS 2013, ERDAS IMAGINE 2013** ***(ALL OF THE LABS ARE WRITTEN ASSUMING YOUR ARE USING THE NEW INTERFACE FOR IMAGINE)***.

If you are using Citrix, click on the 

icon.

ERDAS is a big program that can work slowly, so be patient when letting it start. Eventually, the **ERDAS IMAGINE icon panel** and **viewer** window will appear on the screen. The main icon panel is used to launch the different components of IMAGINE (left-click ***once***, do ***not*** double-click on icons in IMAGINE!). You can split the viewer window as you like, and dynamically link different images to zoom and roam across different views of the same area.

RASTER IMAGE DISPLAY
For this portion you will be working with both the `ikonos_dc.img` and `the 2001_dc_sub.img.`

Display two viewers at the same time.
In the left viewer, display the multispectral Ikonos image:

> **File**, **Open Raster...** (or just right-click on the 2D View #1).
> Navigate to the folder that is storing your data in the Look in: section
> Right click on the raster file `ikonos_dc.img,`
> *Don't click OK yet,*
> Click on **Raster Options** tab,
> display it as **True Color**,
> Accept the following color gun assignments band 4=**Red**, band 3=**Green**, band 2=**Blue** and **Fit to Frame** to fit the entire image in the Viewer.
> Leave default settings for the rest, and left-click **OK.**

In the right viewer display the 2001 image of Washington, D.C.

> From the icon panel select Add views, Display two views
> 2D View #2 should now be in your Contents screen, using the steps above
> Open the file `2001_dc_sub.img`
> display it as **True Color**,
> Accept the following color gun assignments band 4=**Red**, band 3=**Green**, band 2=**Blue** and **Fit to Frame** to fit the entire image in the Viewer.
> Leave default settings for the rest and left-click **OK.**

Link the two Viewers geographically, to spatially coordinate the displays in both Viewers:

> From the Icon panel, choose **Link Views, Link Views.** 
>
> This will show the extant of one image relative to the other image.

In the icon bar, click on the **image info** icon 

, or Right click on the image layer in the contents bar and scroll down to Metadata. This is the metadata information button. This will provide you with the range in pixel digital number values for all of the different bands. You can scroll through the different bands by selecting the drop down menu, or buttons next to the layer number at the top. The image info will also provide you with the projection information, the pixel size, the x and y location of the upper left, right and lower right, left corners of the image, the projection and many other useful things.

ZOOMING AND PANNING

Explore some methods for zooming and roaming on a displayed image:

> In the left Viewer, right-click and find zoom. This will bring a large number of ways to zoom in and out of the image.

Try the magnifying glass tools for zooming :

> Left-click on the zoom in +glass, then left-click on the area you want to see magnified.

Try the "roam image" tool (

) to move around on the images.

After you explored enough, click on the select tool (the arrow icon) and set both Viewers back
to the original display. Right-click in Viewer, Fit To Frame.

Do the images line up?

One way of determining how far off the images are off is to use the measure tool 

Put the inquire cursor on an obvious landmark in on image and then select polyline from the measure list 

Draw a line from where the inquire cursor is in the image that is off to where it is in the other image This should create a line length in meters that can be used to see how far off the images are.

<u>Written Assignment Part 1</u>:

1. What is the pixel size of the Ikonos image? The TM Image?
2. What is the min, max, range, and std. deviation for each of the 4 bands in the IKONOS image? What is the radiometric resolution of the IKONOS image?
3. What projection is each image in?
4. Compare the two images, does there seem to be any obvious errors as to the location of the where things are located spatially? Approximately how far off do the images appear to be?
5. Which of the images covers a greater extant? Why do you think this is the case?

PART 2: SPATIAL TRANSFORMATIONS

BACKGROUND

There are a large number of spatial transformations that you can run on imagery. Most of these are some sort of filter that multiplies the image DN values to create a new image. There are many different uses for these filters, such as detecting edges, smoothing, reducing haze, sharpening, etc. The outputs from these filters vary with the kernel sized use and the pixel size (scale) of the image input. In this section you will use the convolution tool in Imagine to explore what the different images that are created using different window sizes and different spatial resolution imagery.

DATA REQUIREMENTS

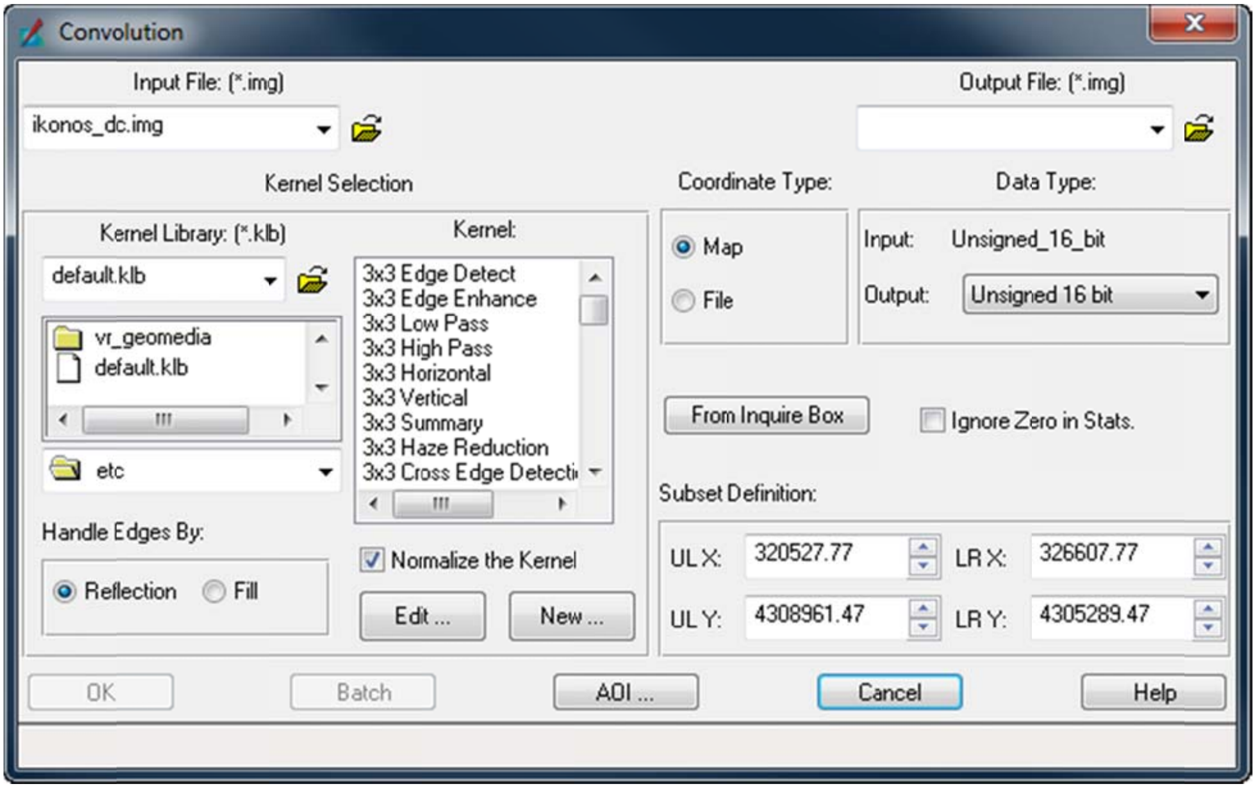
`2001_dc_sub.img`
`ikonos_dc.img`

PROCEDURES

SPATIAL TRANSFORMATIONS

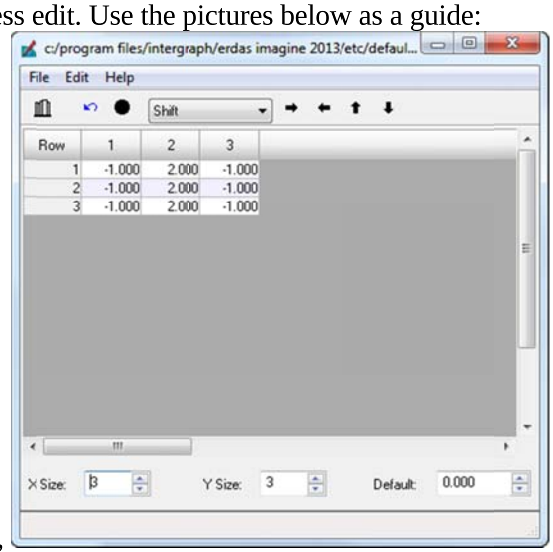
Open the `ikonos_dc.img` in a viewer. Select **Raster**, **Spatial** 

, **Convolution**. The following dialogue box should open up:



You can see in that there are a number of kernels to choose from. To see what each kernel does, left click on the kernel to highlight it, then press edit. Use the pictures below as a guide:

,


,


In this case, the 3x3 kernel, is open that looks for vertical lines. The kernel multiplies the outside rows by -1.00 and the middle row by 2.00. This makes the DN values in the middle row get larger, while the rows next to it are diminished. You can do this same procedure for all of the filters to see what each of the kernels look like before or after running a spatial filter.

Now run the 3x3 Vertical filter on the `ikonos_dc.img` image. Select the `ikonos_dc.img` as the input image, name the output file `ikonos_3x3_vertical.img` making sure to save it to the proper folder and leave the rest as default. The output image should be a four band image, with the 3x3 vertical filter run on each of the individual bands.

Using the same steps, run the five filters below on the Ikonos image and on the Landsat image. Make sure to save all of the images with names that represent the filters so that you can remember which one created each image to answer the questions below:

5x5 low pass
3x3 sharpen
5x5 Sobel 2
3x3 High Pass
3x3 Laplacian Edge Detection

You can experiment with different filters to see what happens when you run them on the images. Some do some very strange things.

<u>Written Assignment Part 2</u>:

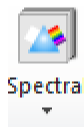
1. What features stand out in the 3x3 Vertical filter image from the IKONOS data? What would this output be useful for?
2. What is the kernel for the 5x5 low pass? What happens to both of the image overall? What could this be useful for?
3. What is the kernel for the 3x3 sharpen? What do you think the weight on the center pixel does? What visual changes to the image output can you detect when you compare this image to both the original image and the 5x5 low pass for both the Landsat and IKONOS images?
4. Of the filters run, which one do you think is the easiest to understand what it did and why?
5. How does each of the different filters impact the Landsat data versus the IKONOS data?

BACKGROUND

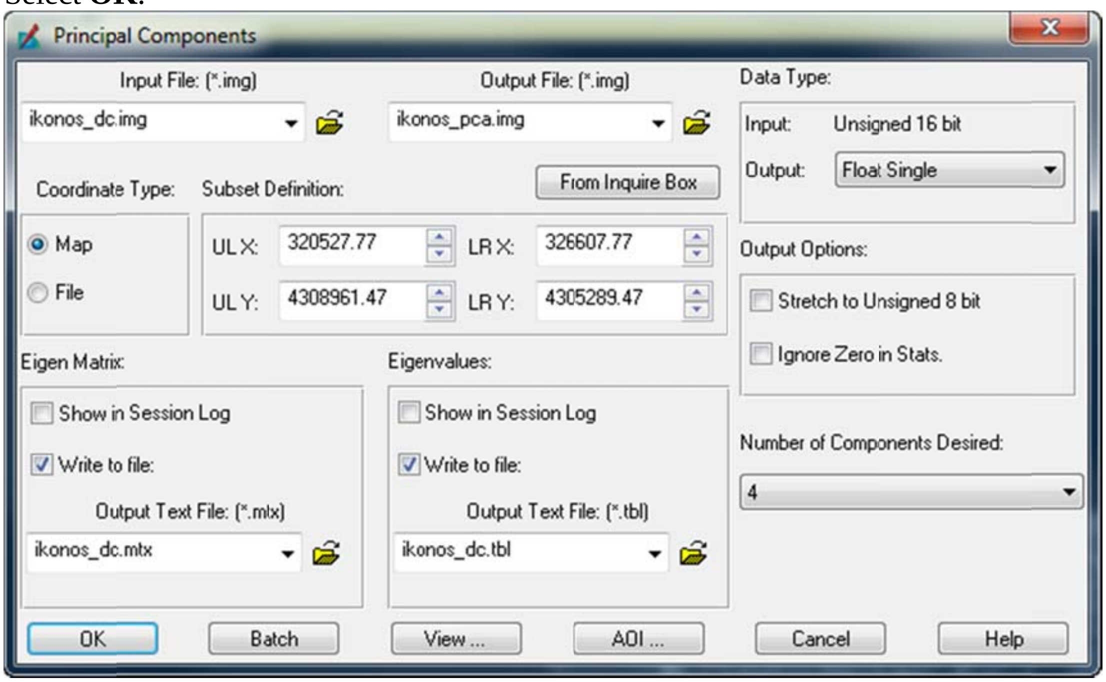
Now that you have explored some spatial measures we are going to look at spectral transformations. In the case of spectral features these measures look at the Principle Components Analysis (PCA) and the Kauth-Thomas Tasseled Cap. Principle Components Analysis (PCA) takes the correlated data out and breaks the image into non-correlated bands. These bands are based on the original data and the amount each band contributes to the new, uncorrelated data is given. Kauth-Thomas Tassled Cap does a similar process for the Landsat TM data, however it generally has

PROCEDURES

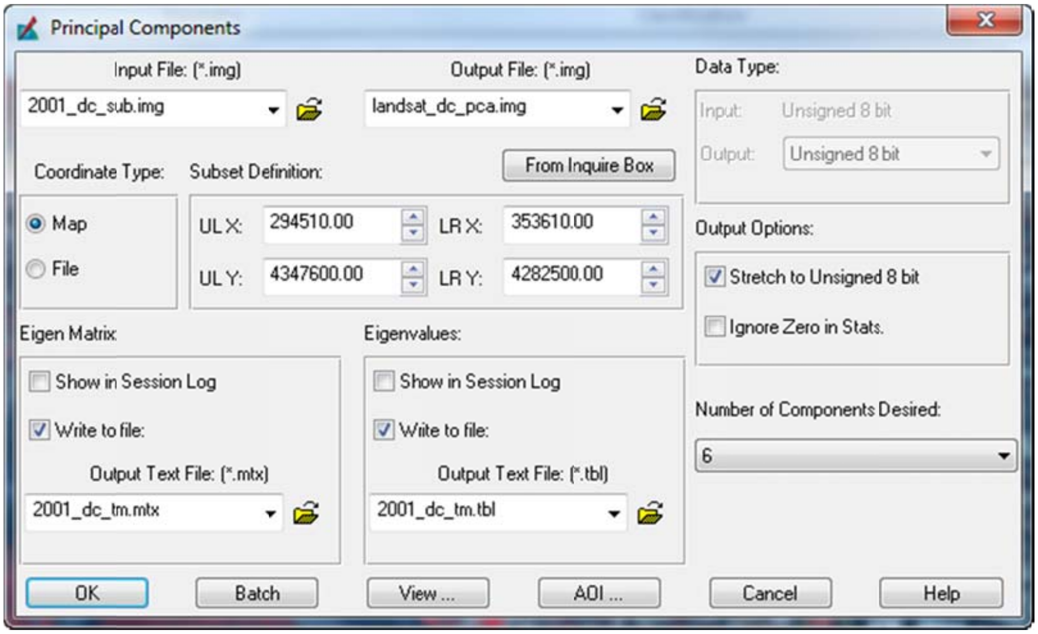
Open the `ikonos_dc.img` in a viewer.

Select **Raster, Spectral**, 

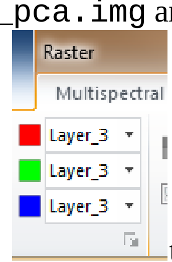
, then **Principal Component.**
The dialogue box below should open up.
Select a name for the PCA out put `ikonos_pca.img`
Select **4** as the number of components desired.
Save the **Eigen Matrix** and **Eigen values** to your folder.
You can use the same file names as are listed below.
Select **OK**.



Using the same procedures, run a PCA analysis on the TM data. Make sure to have 6 components (1 for each band) vs. the 4 for the Ikonos data set. It should look like the screenshot below:



Open both the PCA images you just created `ikonos_pca.img` and `landsat_dc_pca.img.`

Click on **Raster**, then use the Multispectral choice 

to display the display different bands and or combinations of the bands.

The outputs of the PCA are band 1 is the first principal component, band 2 is the second principle component and so on.

Now use Microsoft Excel to open the Eigenvector matrix (*.mtx) and Eigenvalue (*.tbl) files. If you are using the cloud, just open Excel, and select open file (use the all files) file type and open both of the files. In the Text Import Wizard, select Delimited, Next, then click Space, and then Next, then finish.

The Eigenvector matrix numbers (*.mtx file) have four rows for the Ikonos data and six rows for the TM data by four and six columns respectively. The columns correspond to the principal components and the rows correspond to the number of bands of data. The numbers represent a factor score (Eigenvector) that each band contributed to the individual component. If band 4 contributed close to 1.0 to the component, one could then assume that that specific component is a good measure of vegetation cover. The *.tbl file gives you the Eigenvalues for each of the six principal components. The total of these figures will give you the total variance. To figure out the percent variance explained by each of the components, add all of the components up (this is the total variance) and then divide each of the individual components by the total and multiply by 100. This will provide you with the percent variance explained by each of the components.

These values are similar to the data described in Chapter 8, page 298, Tables 8-6 and 8-7, in the PDF that is available in the Electronic Reserves, Image Enhancement, Chapter # 8 DIP.

Put these data in a table and turn them in with your lab.

Written Assignment Part 3:

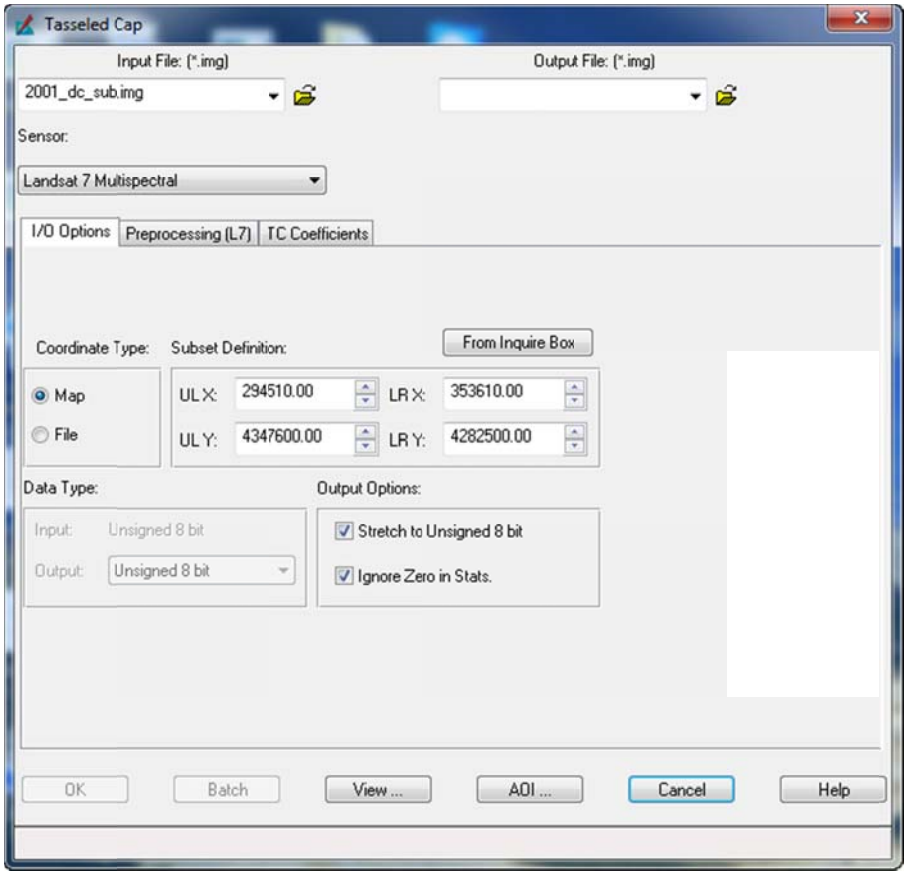
1. What part of the landscape is dominant in each of the four components of PCA from the IKONOS image? Which bands are correlated with each of the four components? Does this relationship make sense?
2. What part of the landscape is dominant in each of the six components of PCA from the Landsat image? Which bands are correlated with each of the six components? Does this relationship make sense?
3. What percentage of the variance is explained by the first two principle components for each of the images? What does this tell you about the data?
4. What would these outputs be useful for and why?

MAKE SURE TO TURN IN YOUR TABLES WITH THE PERCENT OF EACH PRINCIPLE COMPONENT.

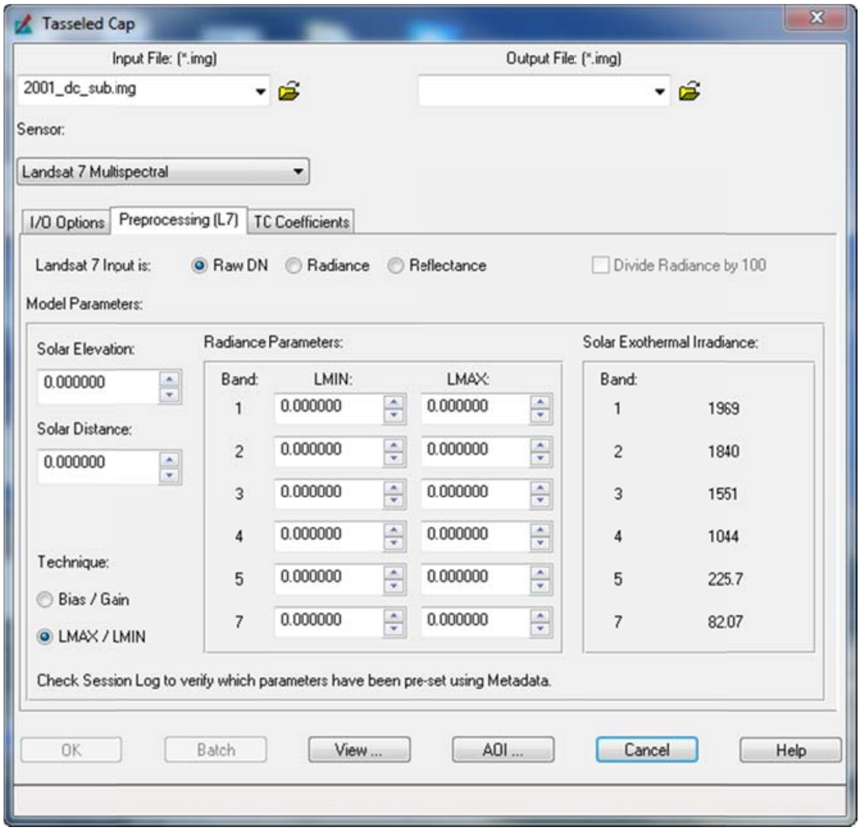
PROCEDURES

Now you will be running the Tasseled Cap Transformation on the Landsat TM data. This is a Landsat 7 ETM+ scene with band 6 (the thermal band) removed.

Go to **Raster, Spectral, Tassled Cap.** As the input use the `2001_dc_sub.img,` choose a name for the output that you will remember `(tassled_cap_dc.img)`. Change the Sensor **to Landsat 7 Multispectral**, **Stretch to Unisgned 8 bit**, and **Ignore Zero in Stats**.



Click on the **Preprocessing Tab**, the data are Raw DN. You need to input the Solar Elevation and the LMAX/LMIN values for each of the bands. This information is given in the Metadata file that is found in the Lab 2 data folder (LE70150332001214EDC00_MTL.txt, open using Microsoft Word). Additionally, you will need to put in the solar distance in astronomical units. Values for this can be found in the Excel spreadsheet (earth_sun_distance_astronomical_units.xls) in the Lab 2 folder. You will need to figure out the day of the year the image was taken. Do this by knowing the date when the image was taken and using a conversion that can be found online (just Google one).



Once you have filled this out, click **OK** and run it.
*You can use the Help button to determine which band is which in the output (i.e., what is brightness, greenness, and wetness).

Written Assignment Part 4:

1. What is the difference between the 6 PCA output bands and each of the 6 outputs from the tasseled cap? Are there significant differences, if so where and what types of features are highlighted in each of the bands?
2. Each of the bands should be the components of the tasseled cap. What are the first three bands supposed to represent? Do these features seem to be highlighted in your output from the Tasseled Cap? Why or why not?
3. What are you doing when you run the preprocessing tab?