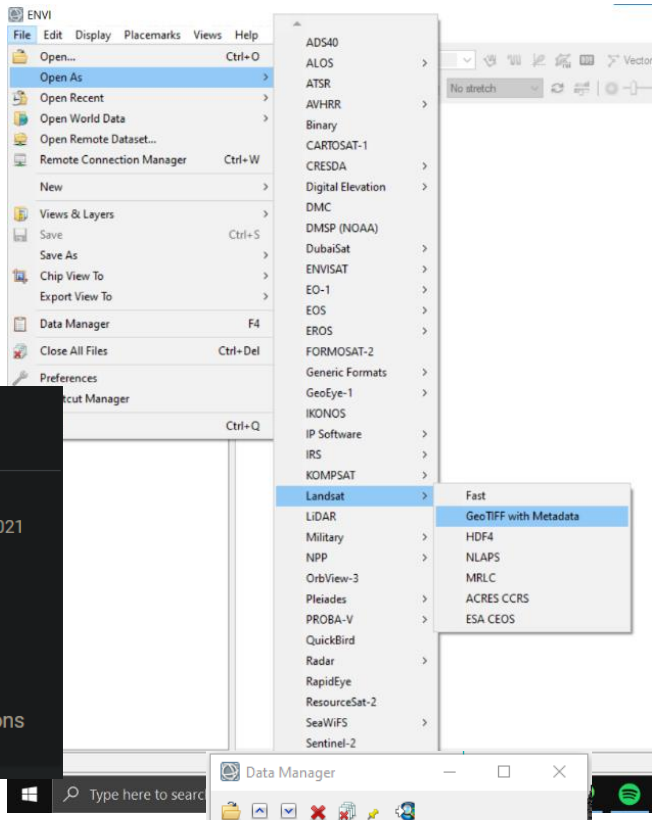
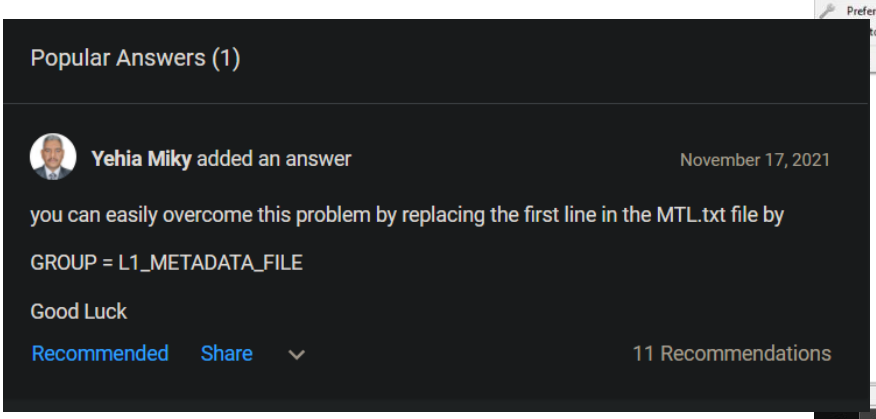
NOTES AND CONTENTS

2-Basics:

2-3 – open satellite imagery:

You can open Landsat data like this image, but ENVI 5.3 can not open Landsat 8 collection 2, because of some changes in the metadata

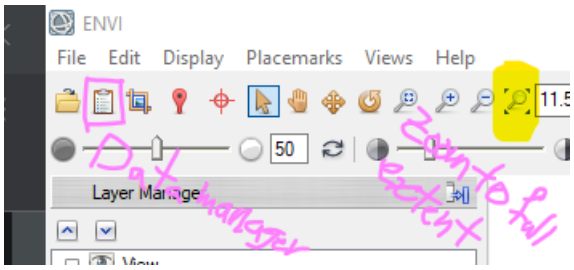


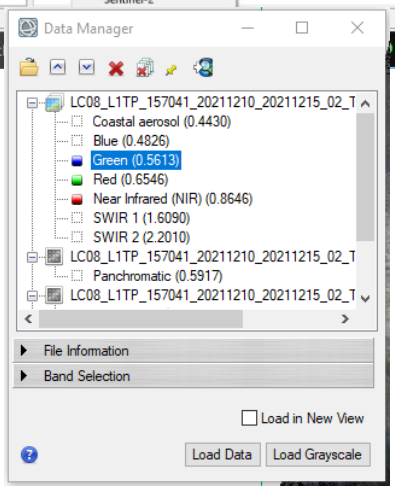


2-4 Data Manager:

Opens Bands.

And you can select the color compostion that you want

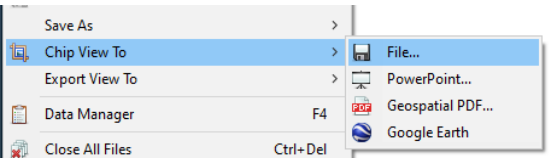




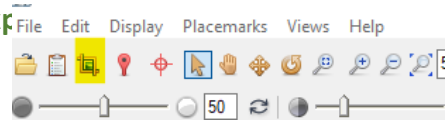
2-5 – Save as:

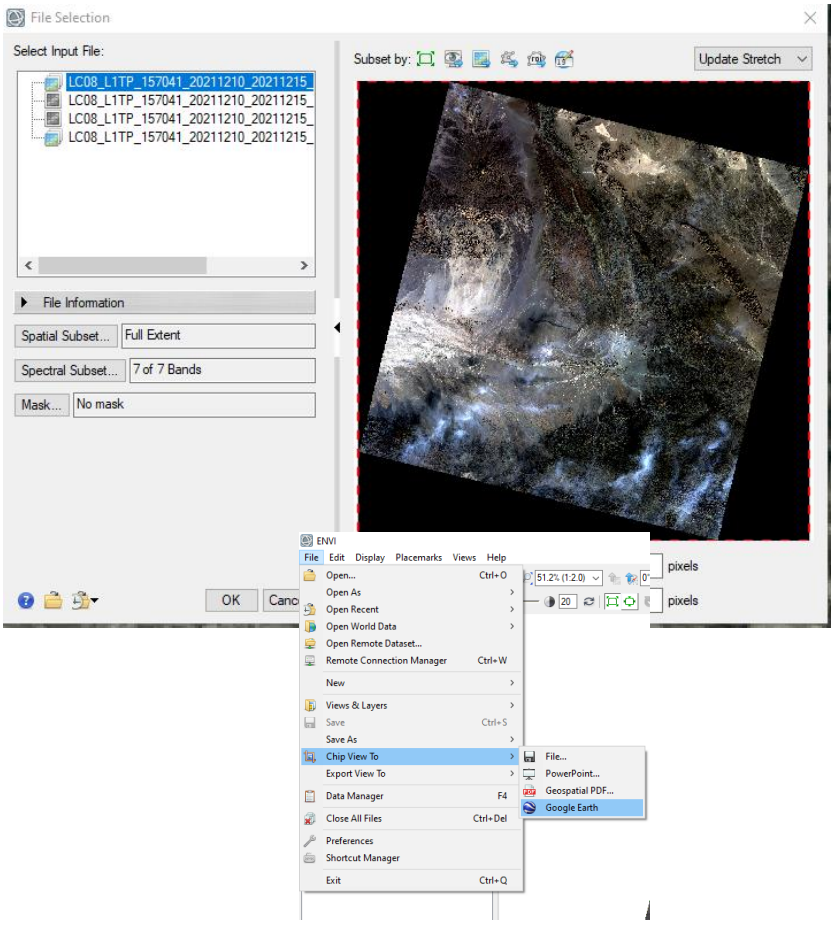
You can save as any protion of bands by using **specteral subset** and any protion of the map by using **spatial subset**.

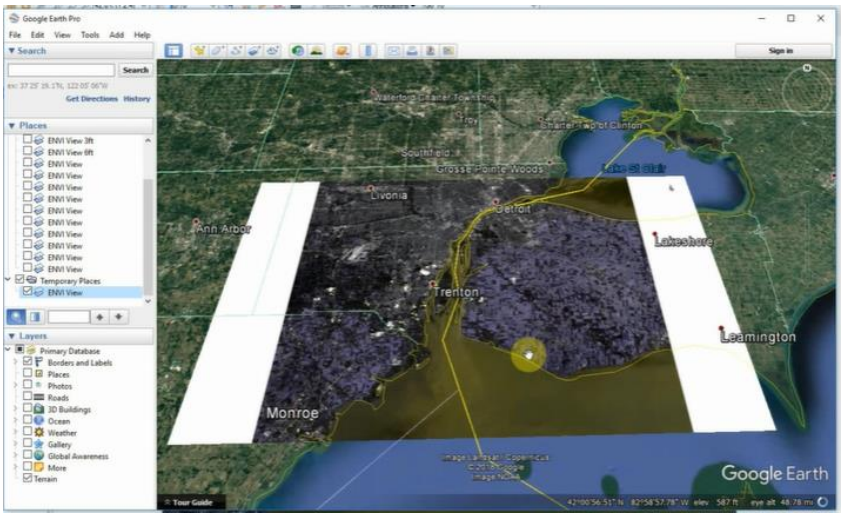
You can also save the portion of the map that you are zooming at at the moment by using **Chip to View.**



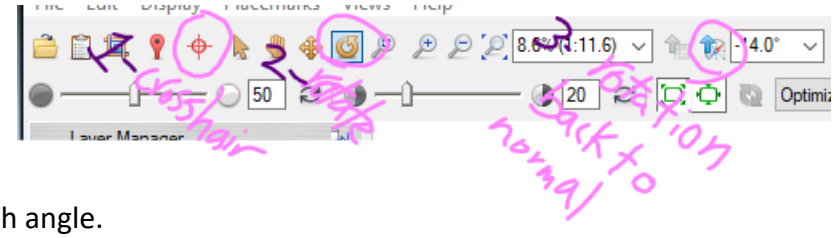
2-9 – Exp







2-10 – Basic Tools:

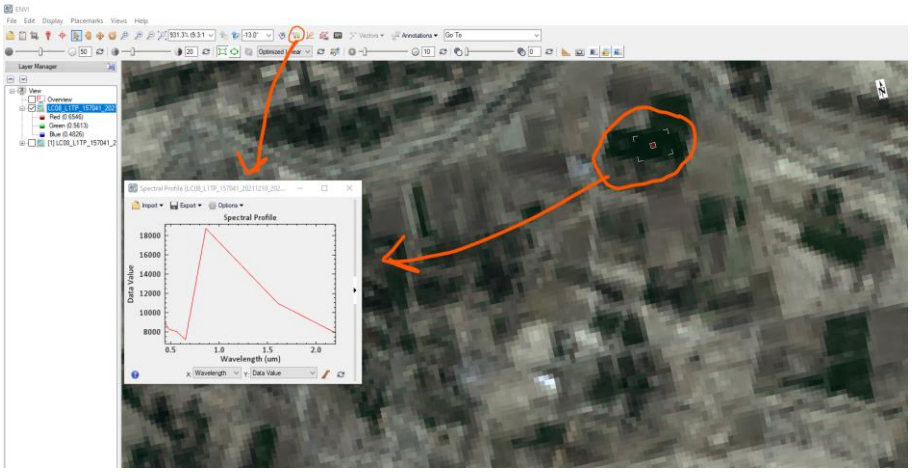


1- Crosshair tool is to monitor the pixel values when hovering over them
2- Enables you to rotate the image
3- Rotates the image back to normal to-north angle.

Moien Rangzan – moienrangzan@gmail.com

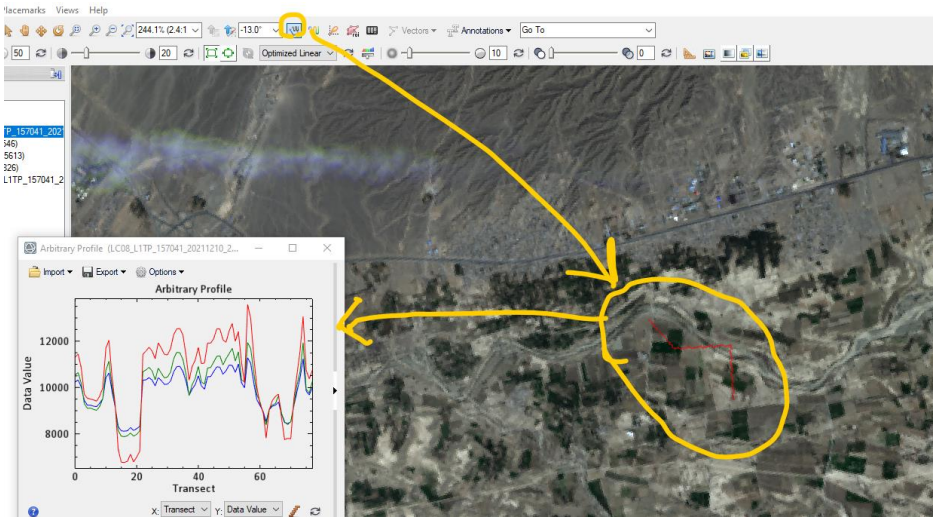
2-11 – Basic Tools2:

Specteral Profile:



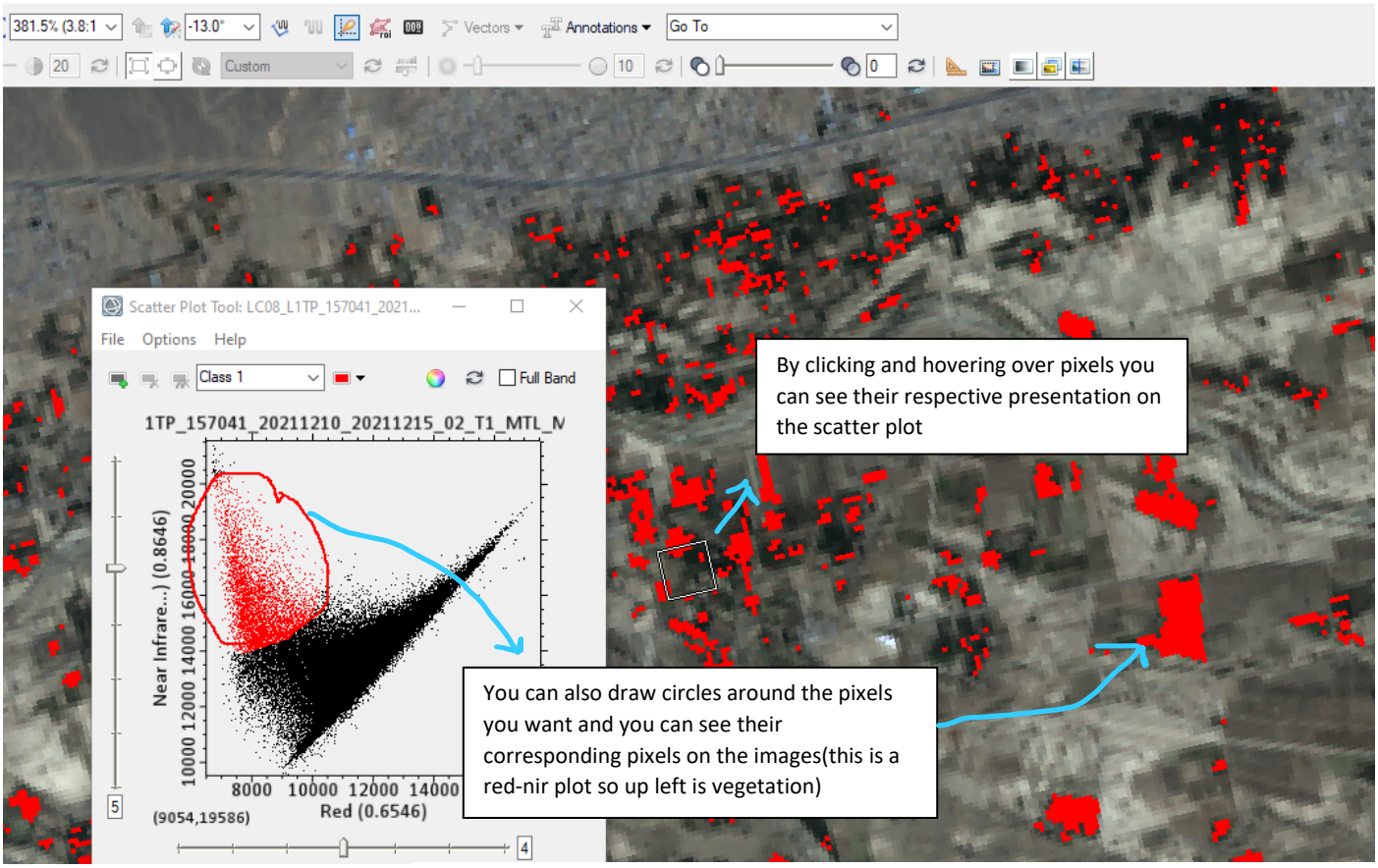
Spatial Profile:

Draw a line and when you are done Double-click on the last point, then you can sea the Spatial Profile.



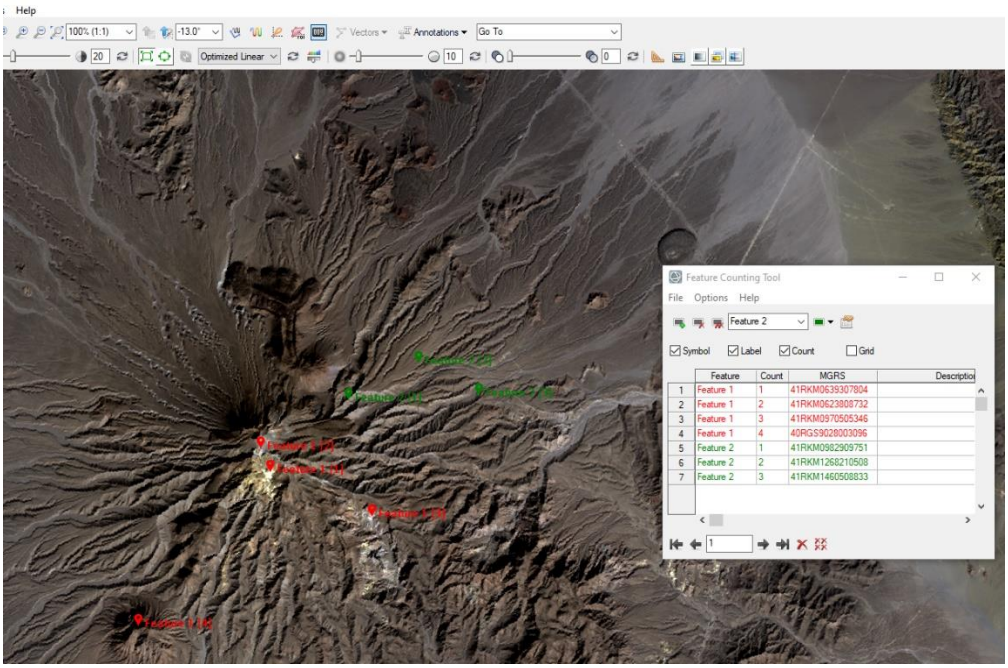
Moien Rangzan – moienrangzan@gmail.com

Scatter Plot



Feature Counting Tool

With this tool, you can use pins to mark and count features in you image.



Brightness and Contrast

Moien Rangzan – moienrangzan@gmail.com

2-14 – Edit Envi Header:

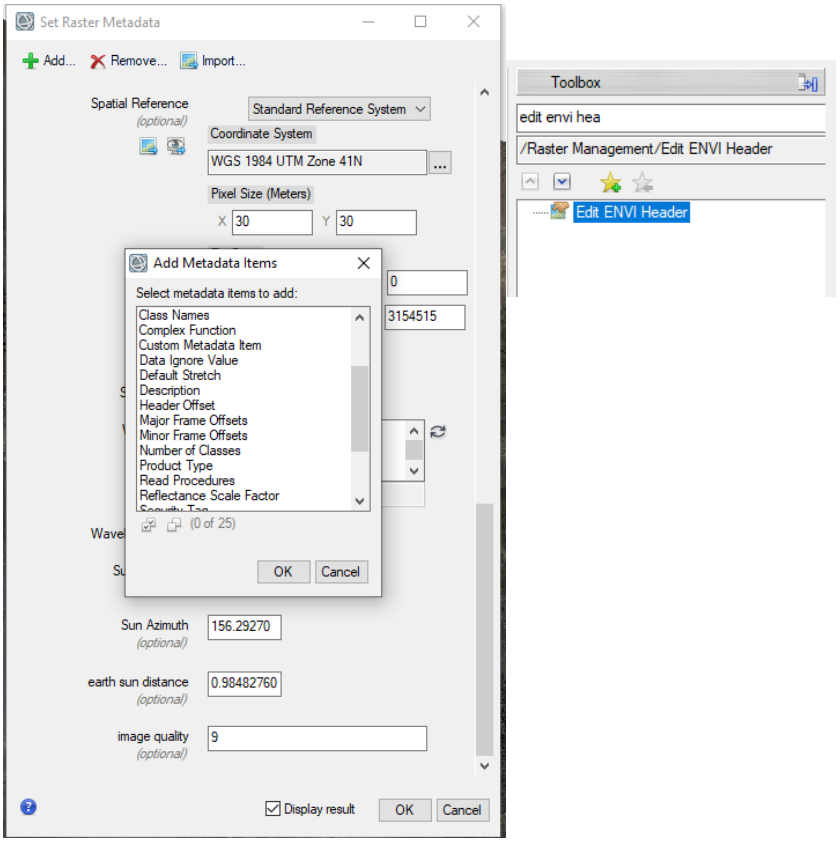
Eidts the metadata

With the add butto you can add section to medata data like **defult stretch.**

Data ignore value: sets the values that we specify to NULL

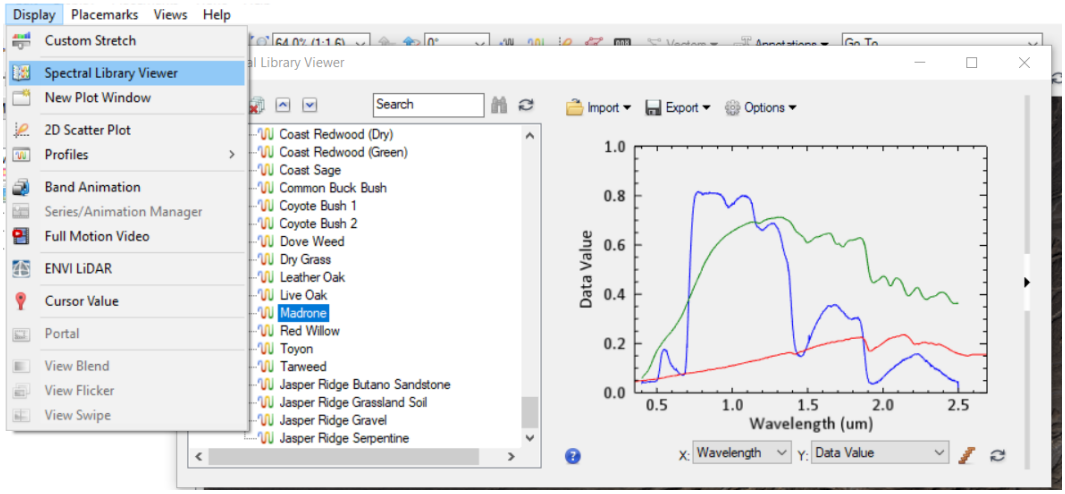
For example borders of landsat images are

0, we can turn them to null.



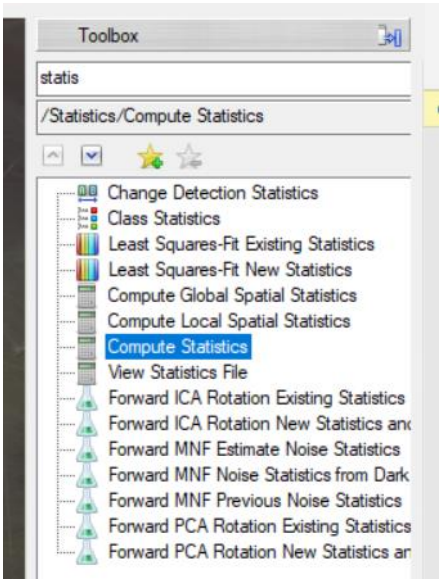
2-15 – Spectral Library

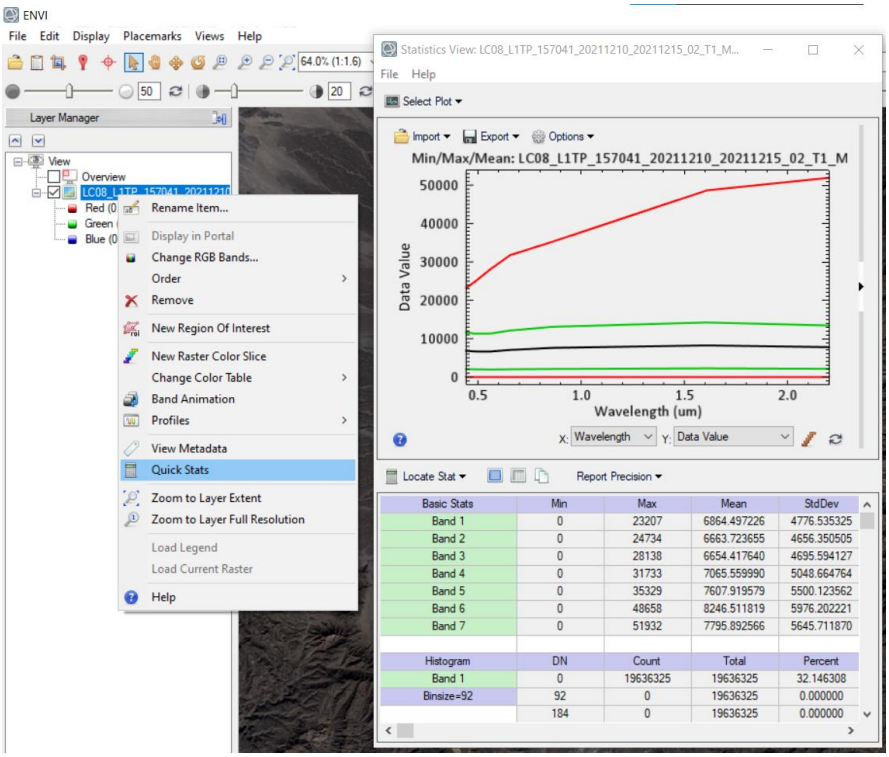
A library with thousands of spectral profiles, and you can import your own data into it and export data.



Moien Rangzan – moienrangzan@gmail.com

2-15 – Full Statistics and Quick stats





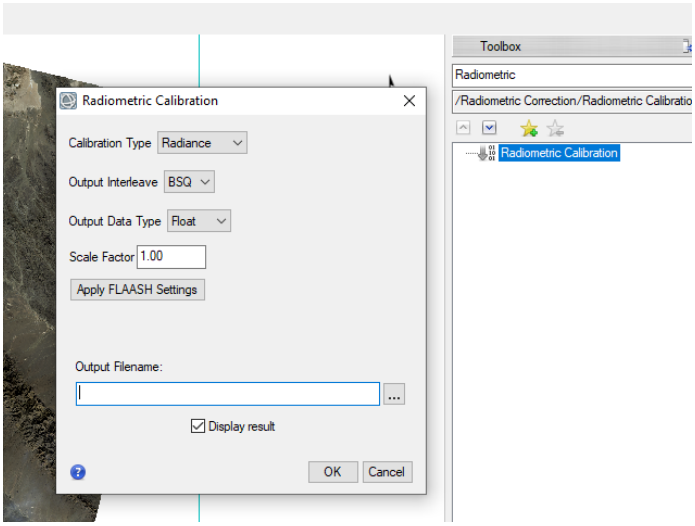
3-Atmospheric Corrections:

3-18 – Radiometric Correction

If the borders of your image are 0 and not Null values, you have to go to (2-14) header and correct it

If you are planning to apply FLAASH atmospheric correction, apply its setting.

Choose an output folder.

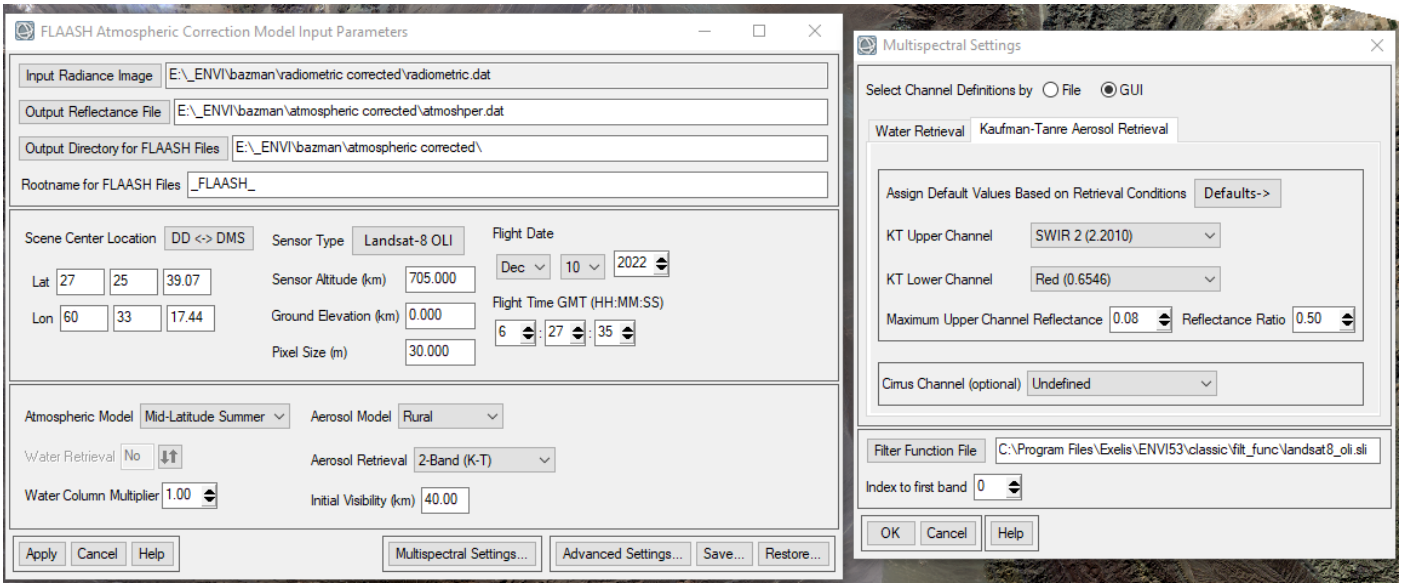


3-19 Atmospheric Correction

You can apply the setting as it is shown in the video but this table in FLAASH tutorial uses the latitude and month of the acquisition to suggest an **Atmospheric Model**

Latitude (°N)	Jan.	March	May	July	Sept.	Nov.
80	SAW	SAW	SAW	MLW	MLW	SAW
70	SAW	SAW	MLW	MLW	MLW	SAW
60	MLW	MLW	MLW	SAS	SAS	MLW
50	MLW	MLW	SAS	SAS	SAS	SAS
40	SAS	SAS	SAS	MLS	MLS	SAS
30	MLS	MLS	MLS	T	T	MLS
20	T	T	T	T	T	T
10	T	T	T	T	T	T
0	T	T	T	T	T	T
-10	T	T	T	T	T	T
-20	T	T	T	MLS	MLS	T
-30	MLS	MLS	MLS	MLS	MLS	MLS
-40	SAS	SAS	SAS	SAS	SAS	SAS
-50	SAS	SAS	SAS	MLW	MLW	SAS
-60	MLW	MLW	MLW	MLW	MLW	MLW
-70	MLW	MLW	MLW	MLW	MLW	MLW
-80	MLW	MLW	MLW	SAW	MLW	MLW

Table 2-2: Selection of MODTRAN Model Atmospheres Based on Latitudinal/Seasonal Dependence of Surface Temperature



3-20 -Dark object subtraction

You can not use the same radiometric calibration for both FLAASH and DOS,

Method: we have to subtract the lowest DN that we have from the other DNs of the each band

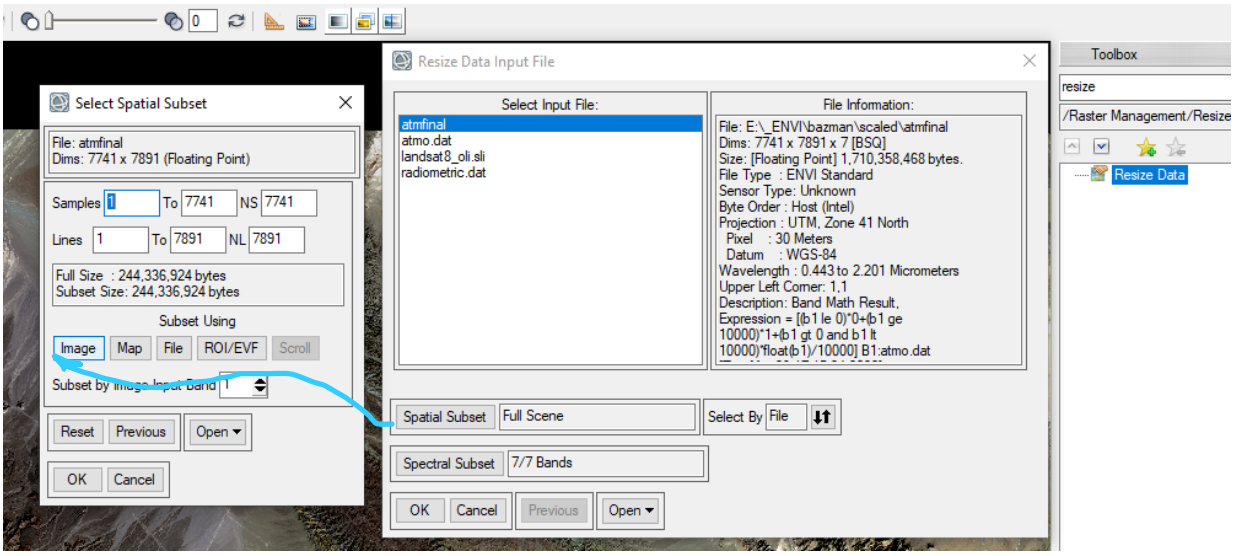
Locate Stat -> choose your band, find the lowest DN,

Note: if the lowest DN has been occurred a lot of time (e.g. 1000) it is better not to use DOS on that band because youll get a lot of zero pixels (e.g. 1000)

4 -Remote Sensing Process

4-22 – Resize (4-23 is better)

It is note actually resize but it is spectreal and spatial subset

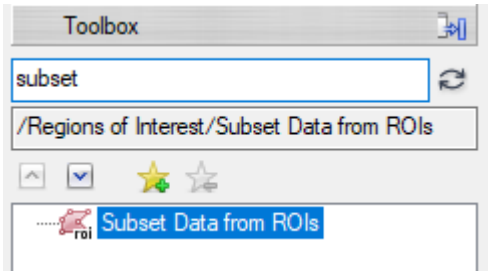


4-23 – Subset Data From ROI:

This way you can use rotated image to create your roi.

You can create a line, and hold *Cntrl* to create a reactange instead of choosing al verseties.

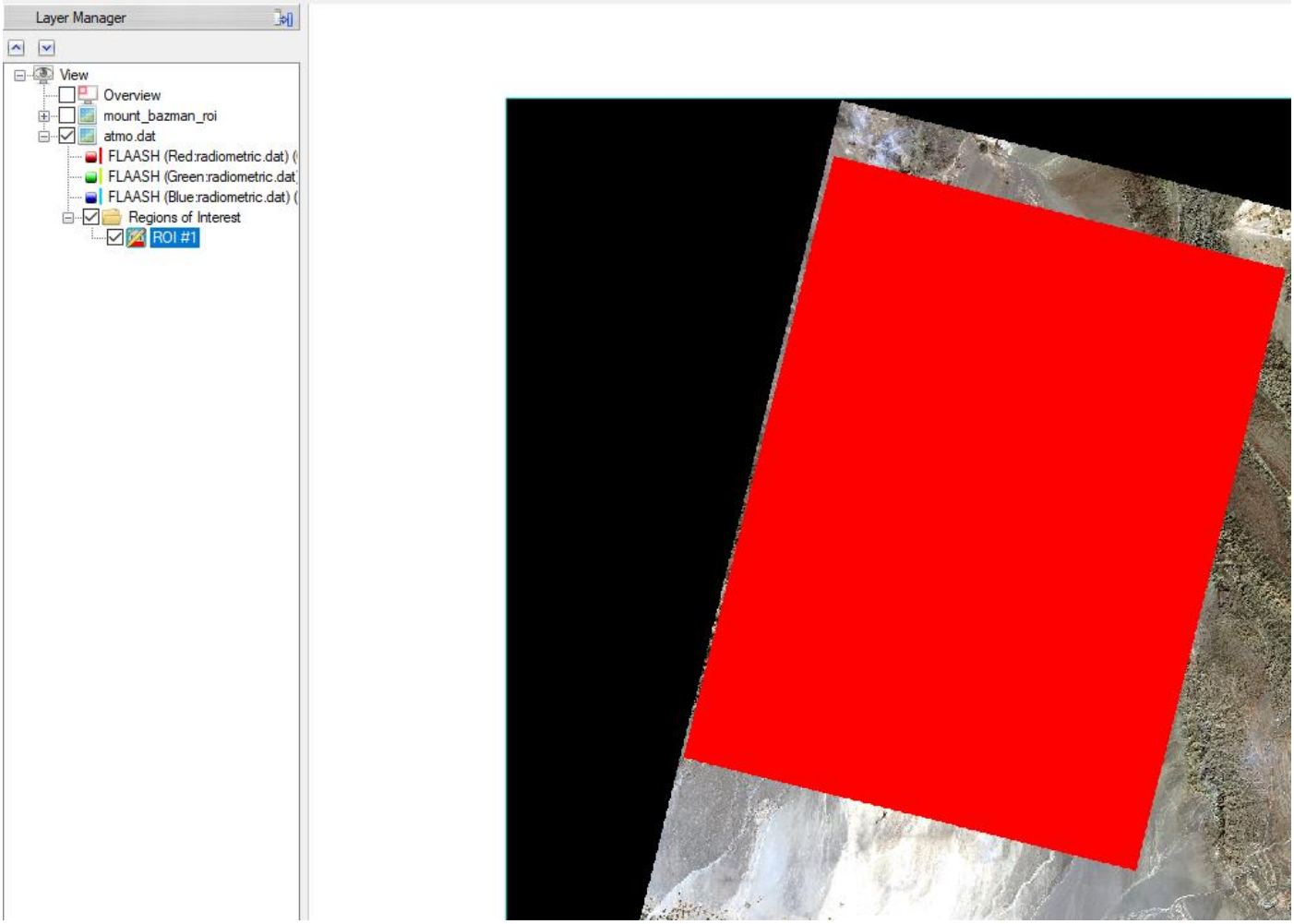
After choosing your ROI go to the *Subset Data from ROIs* .



Important note: after Drawing the ROI u must right click on the drawn area and Click Accept Polygon

Error: "Array dimensions must be greater than 0." The result may be invalid.

This error message usually indicates that one or more of the ROIs specified for the processing contains no pixels. For example, perhaps a ROI has been drawn, but has not yet been accepted. You usually accept a drawn ROI by right clicking after drawing the ROI, and choosing Complete and Accept Polygon. If you choose to only Complete the polygon, and not Accept it, then there will not be any pixels in the ROI until that polygon has been accepted by right clicking again and choosing Accept Polygon.

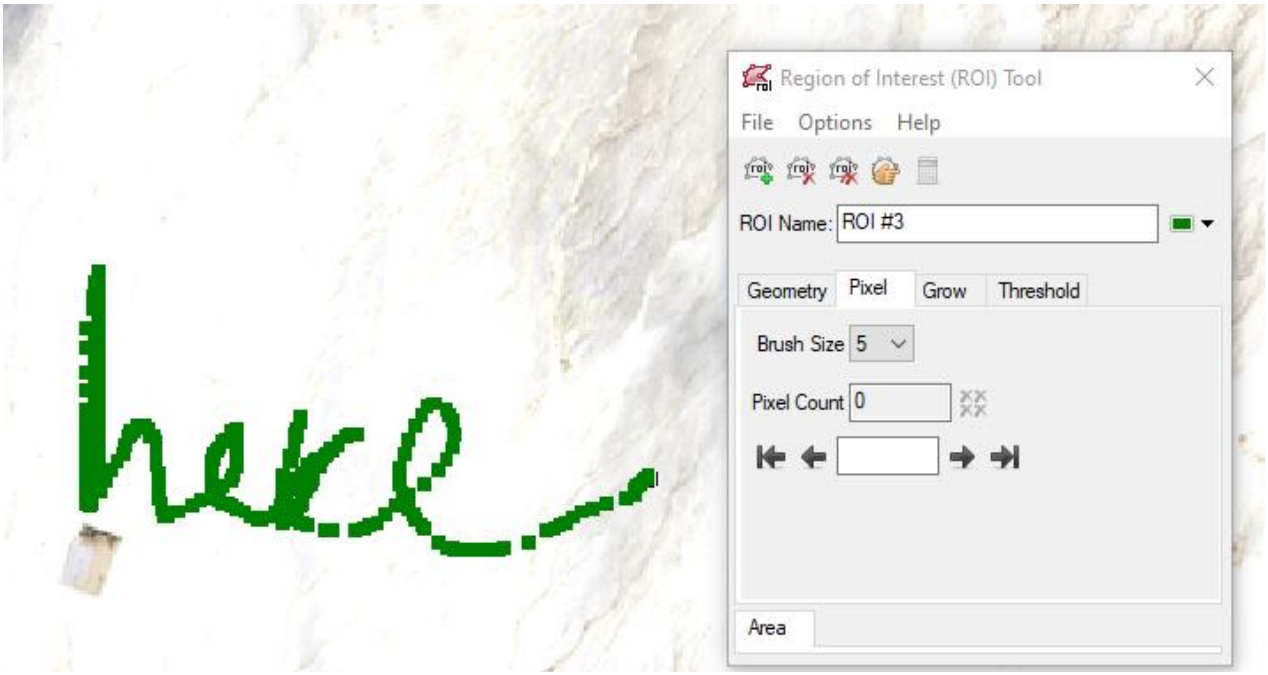


4-24 Subset Data based on Spectral Properties

ROI Tool gives you a lot of options,

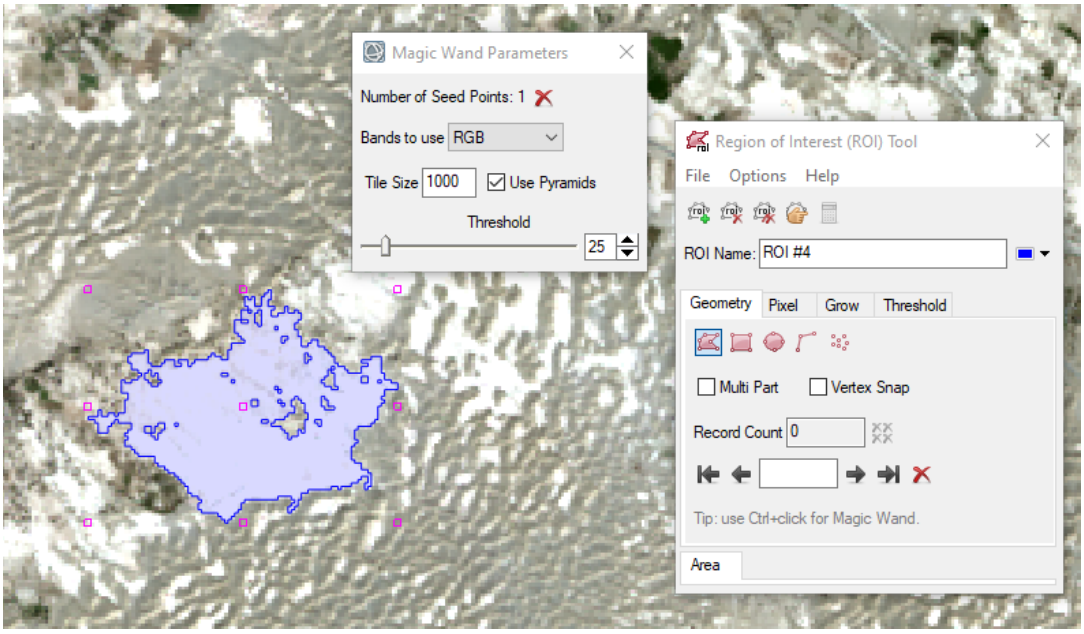
Pixel wise:

Draw to crate your area



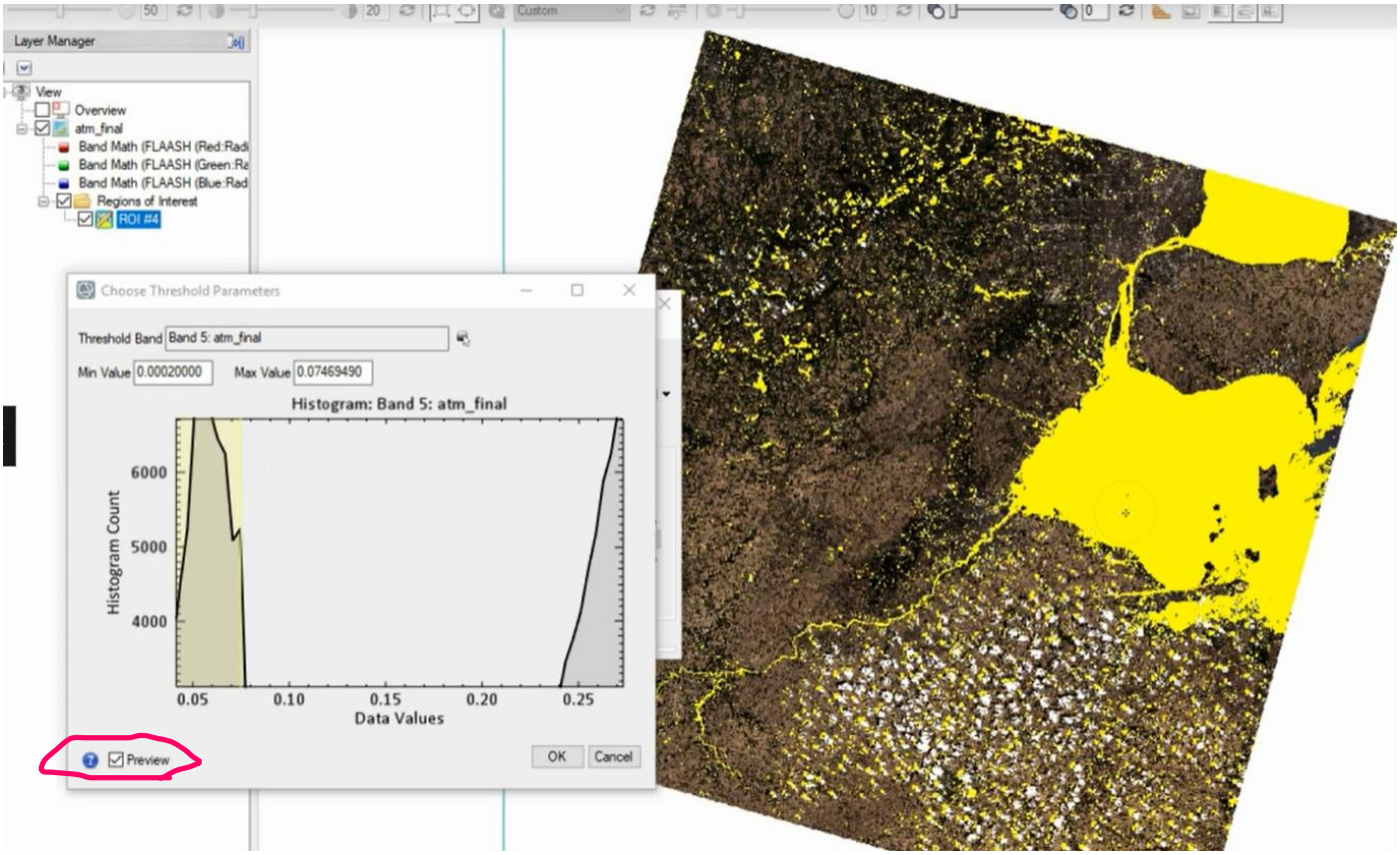
Magic wand:

You can select polygon tool and pres Cntrl then click on an are to capture a area that has the same texture



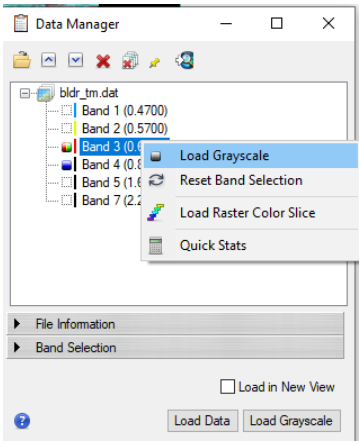
Threshhold: make sure the preview is on

You can select band threshold.



Moien Rangzan – moienrangzan@gmail.com

4-25 – Lab1 Notes:

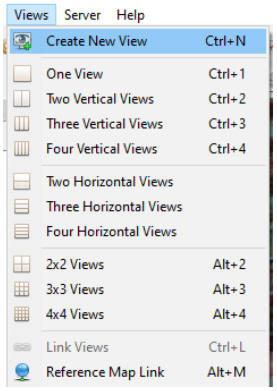


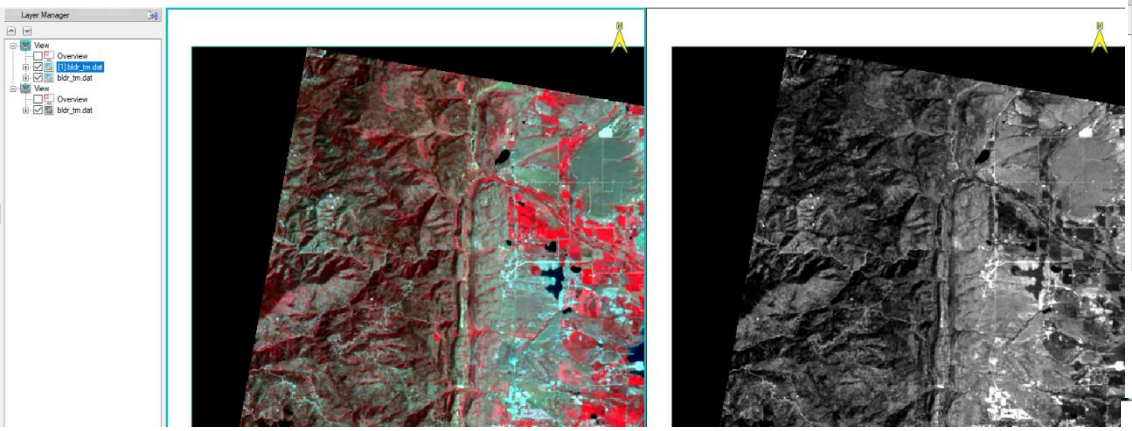
Gryscale:

note that you can load a specific band as a grayscale image by right-clicking on that band and selecting Load Grayscale.

Views:

You can open multiple views and you can also link them together

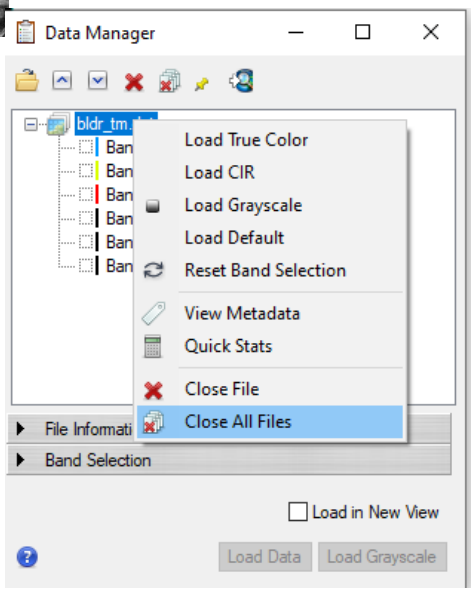




Closing Files:

Once a file is opened in ENVI, it always remains open until the session is ended or you manually choose to close the file. However, because data from the files are only read when needed, having many files opened does not consume any memory. Nonetheless, sometimes it is useful to remove an opened file from the ENVI session.

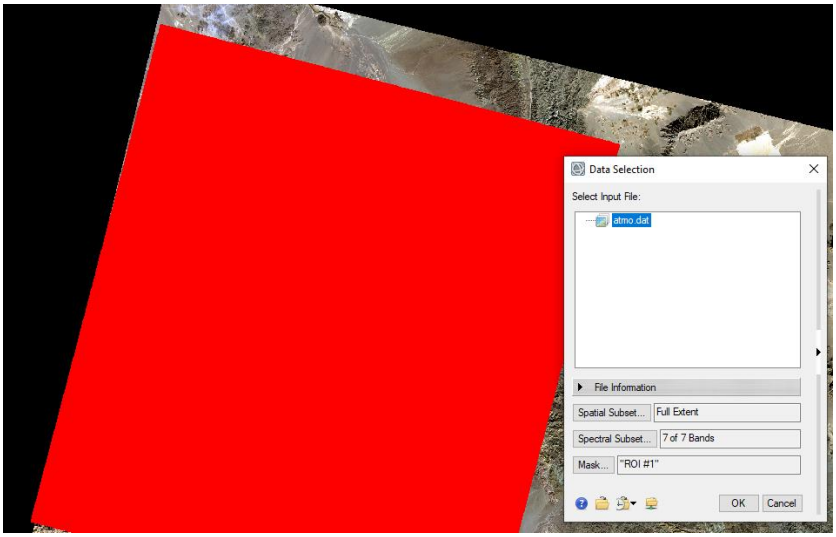
Open the Data Manager and click on Close File button or Close All Files button. You can also close files by right clicking on a file in Data Manager and selecting either Close File or Close All Files.



Moien Rangzan – moienrangzan@gmail.com

4-26 – Mask

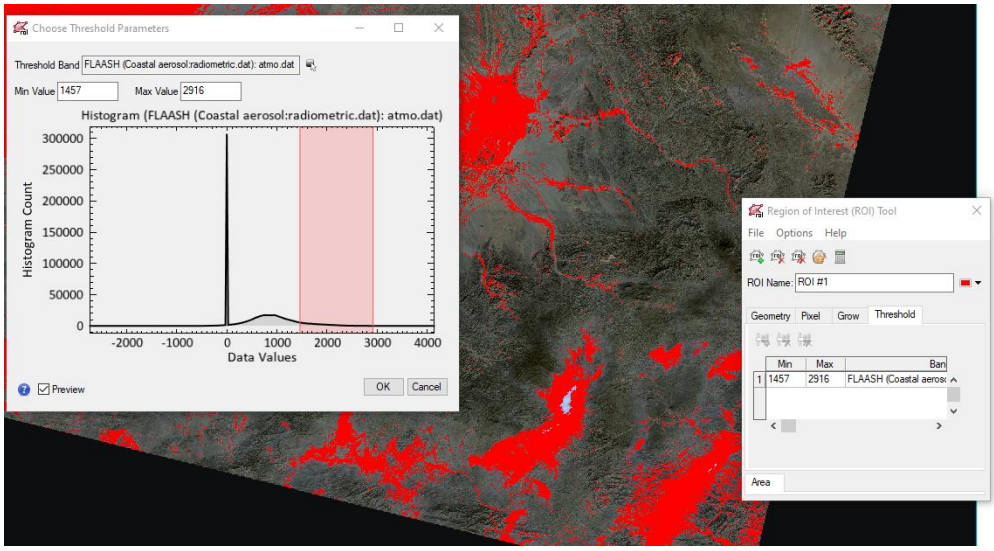
After creating your ROI you can go to File->Save as-> (ENVI…). Then select mask and choose your ROI.



4-27 – Band Treshholding (ROI)

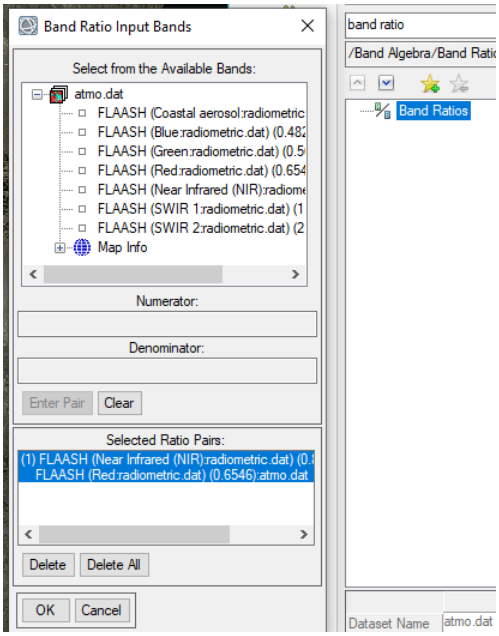
Note: when you drag from left of the histogram a threshold appears, if you want two have 2 way tresh hold drag 2 times

Note if you cant see the preview it is probably cause that you have another layer open, make sure to close them like was said in 4-25

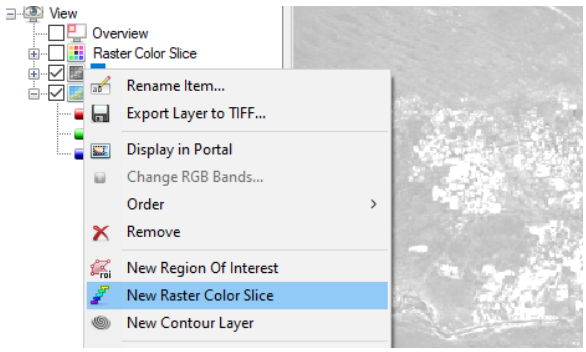


4-28 – Band Ratio

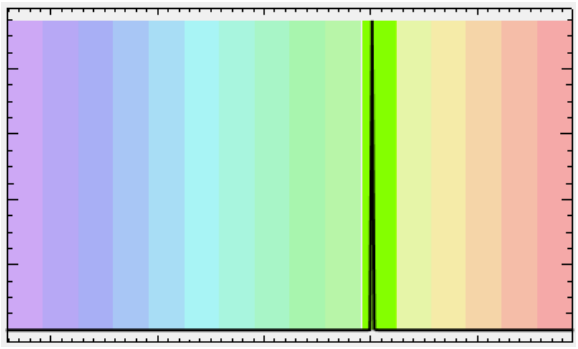
Choose you band (we are caluating Simple Ratio (SR) here)-> Enter Pair-> ok -> save your file

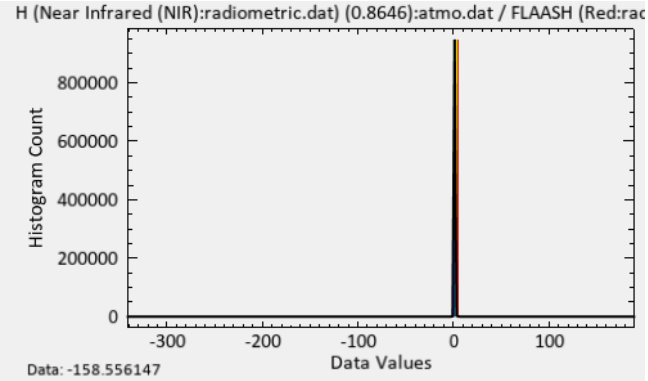


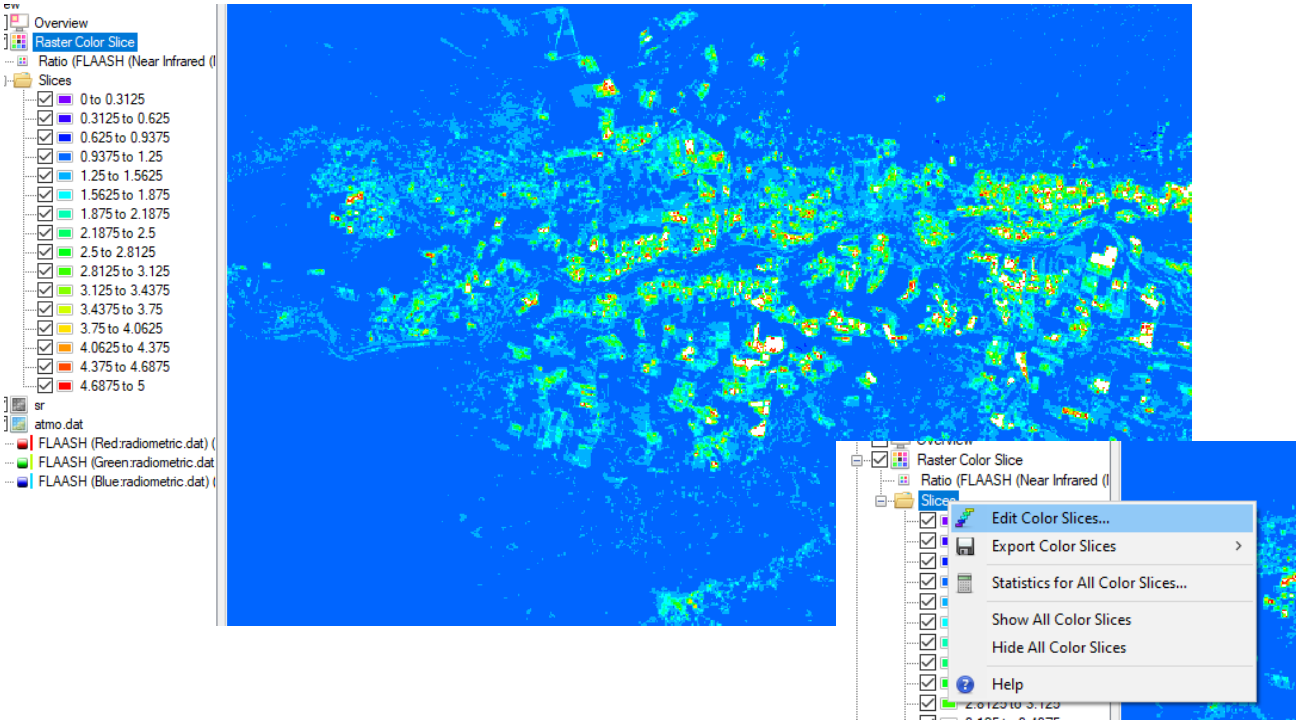
By defult th ratio will be in one band and grayscale, to add color to it (like arcgis Symbology) you can use **Raster Color Slice**



You must change the coloring min max to match the histogram using  . and get a result like right image.





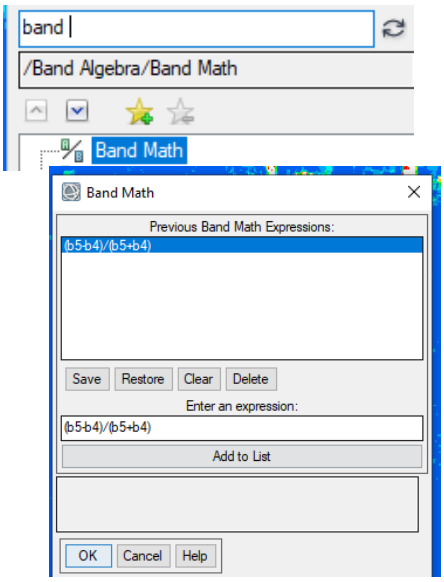


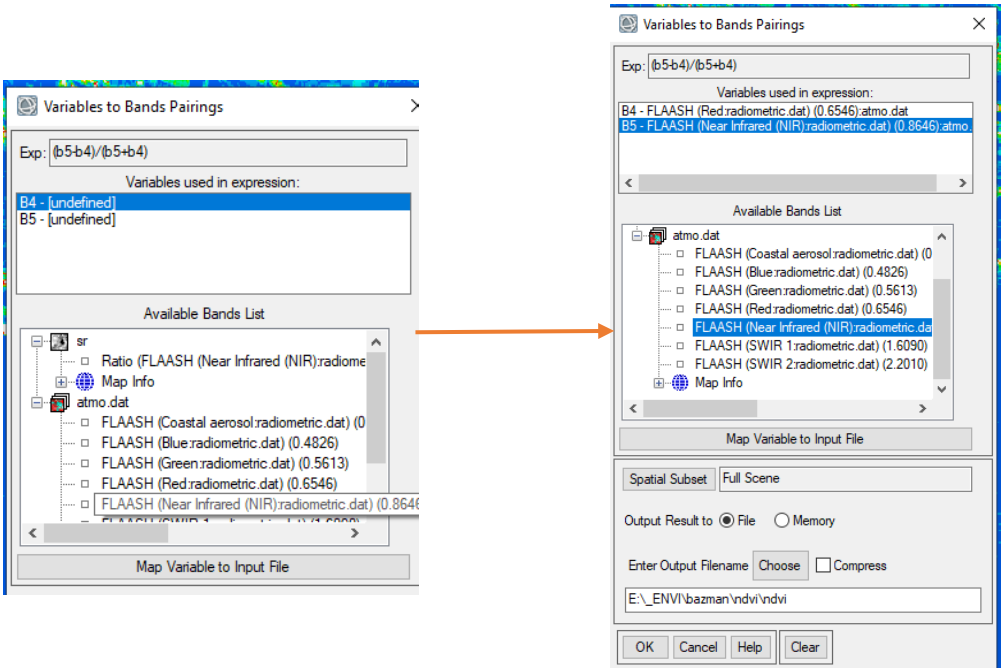
Moien Rangzan – moienrangzan@gmail.com

4-29 – Band Math

When you write your formula after you hit ok you need to

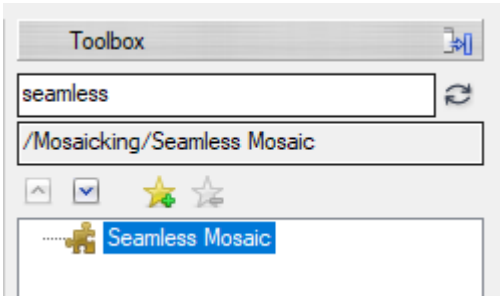
Assign the Variables you used to the Image bands.





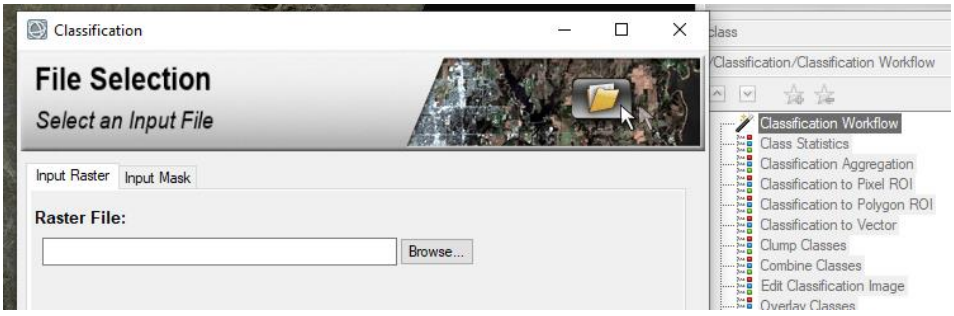
4-33 – Mosaicing

You can use seamless Mosaic Tool



4-35 – Classification Workflow

Does both supervised and unsupervised.



Moien Rangzan – moienrangzan@gmail.com

4-37 – Pan Sharpening
SPEAR pan sharpening

5-39 Masking
You can create a mask from ROI using *Build Mask* tool.

And you can apply that mask on your image using *Apply Mask* tool.

6- intermediate and Advanced

6-40 – Converting Landsat Thermal bands' pixlel values into Surfave Temprature
You just need to select landsat thermal and use Radimetric Calibrations, and choose Surface Temprature instead of radiance and reflectance.

6-41 – Image change detection and ENVI change workflow

6-42 – Image Registration
To co-register images of the same area but from different acquisitions

6-43 Anomaly Detection
RXD and UTD methods

6-44 Thematic Change detection

6-45 – Time Series
File-> New-> Build Raster Series

6-46 Burn Indicies
- Layer stacking
- Spectral Indices: has a lot of pre written spectral indices.
- Burn area index

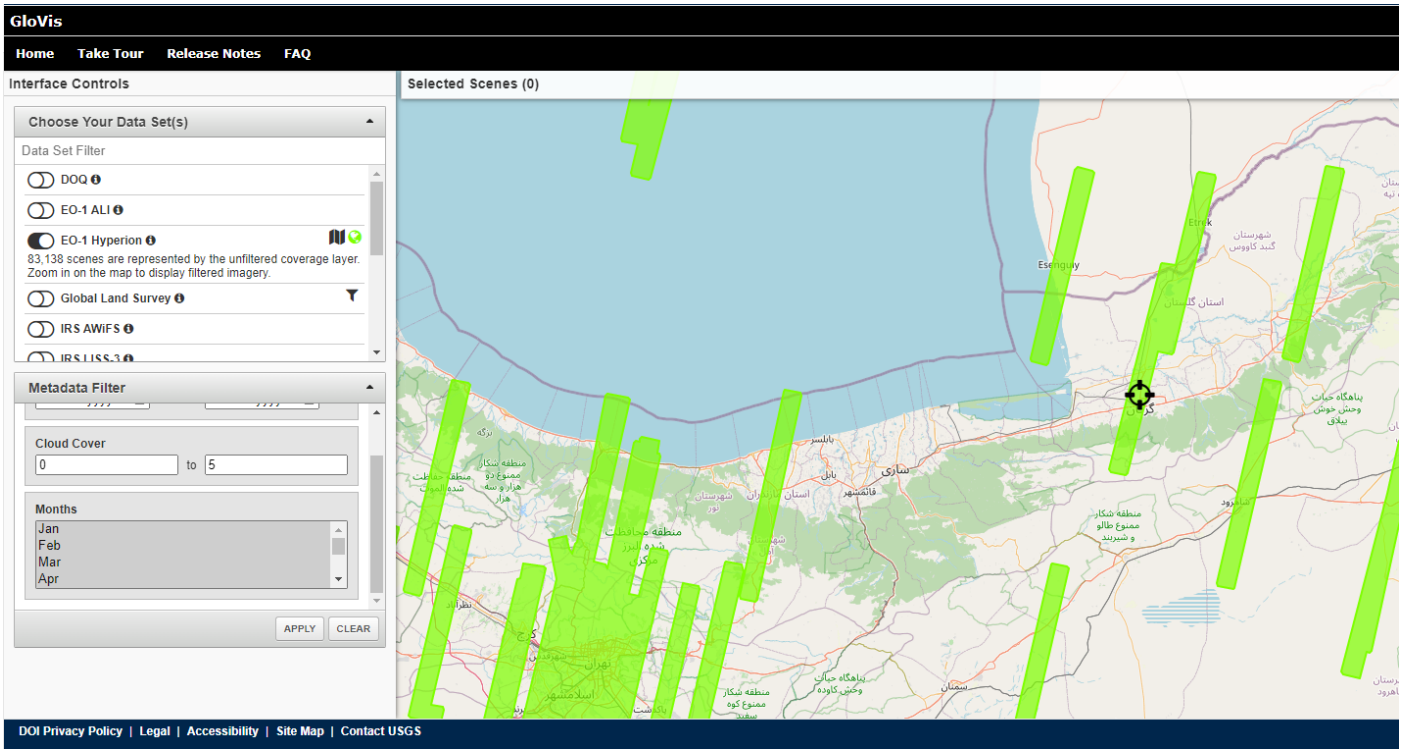
6-47 – Mosaicing Advanced
Seamless mosaic

8- Hyperspectral

Envi Tutorial

We get the data from https://glovis.usgs.gov/ or earthexplorer

The closest data to Bandar Torkaman is the one that passes Gorgan.



8-1 – EO-1 Hyperion products:

The Level 1R data set consists of radiometrically-corrected images (watts/(sr-micron-m2)x100), formatted as HDF files, and metadata in binary and ASCII formats.

Level 1Gst is terrain corrected and provided in 16-bit radiance values.

We work with Level R data.

Level 1T it is the same as R but it is georeferenced (so when you open it in envy it is oblique)

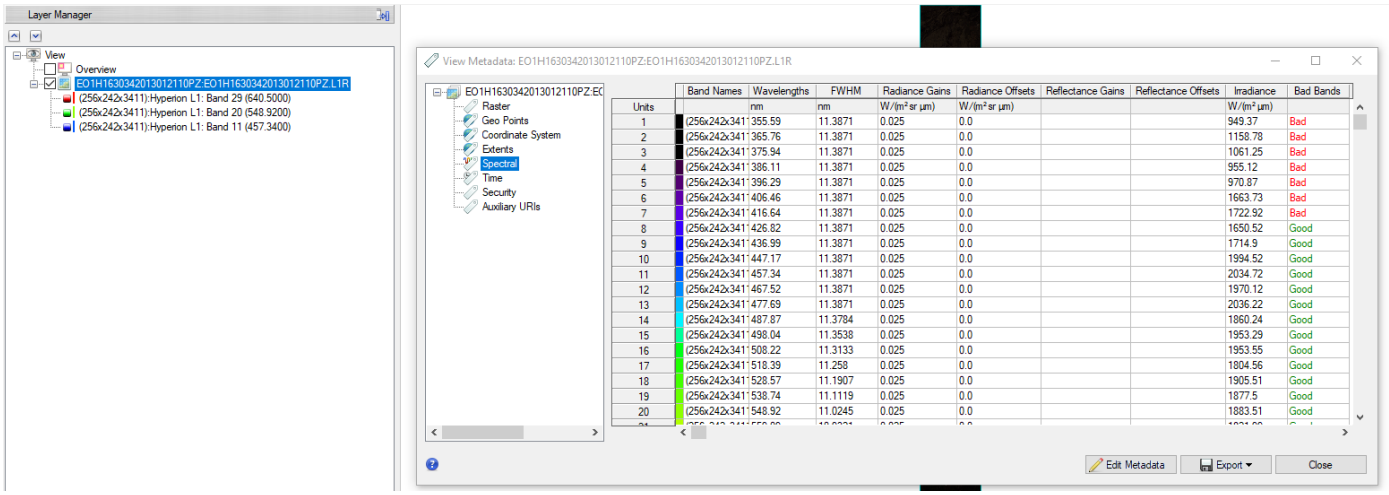
But other levels only give you for qorner lat and longs, so you do the gerefrencing on your own.

8-2 Radiometric Correction:

Gain and bias:

Right-click on file -> View metadata -> spectral.

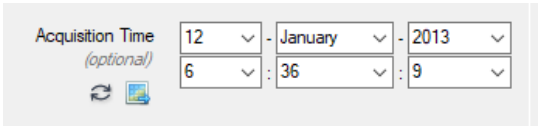
You can actually see the- gains and biases and not waste you time looking at the MTL file.

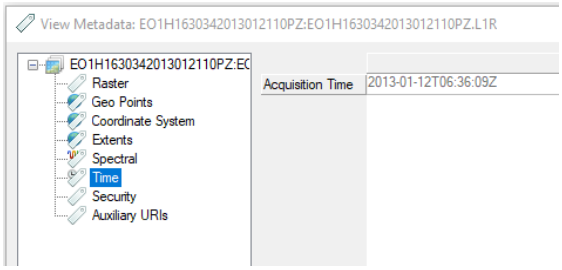


"Bands 1-70 are the visible/near-infrared (VNIR) bands. Later when you calibrate the data, the ENVI Radiometric Calibration tool will multiply a gain value of 0.025 to each pixel in this band range, which is the same as dividing each pixel by 40. Bands 71-242 are the shortwave-infrared (SWIR) bands. The Radiometric Calibration tool will multiply a gain value of 0.0125 to each pixel in this band range, which is the same as dividing each pixel value by 80."

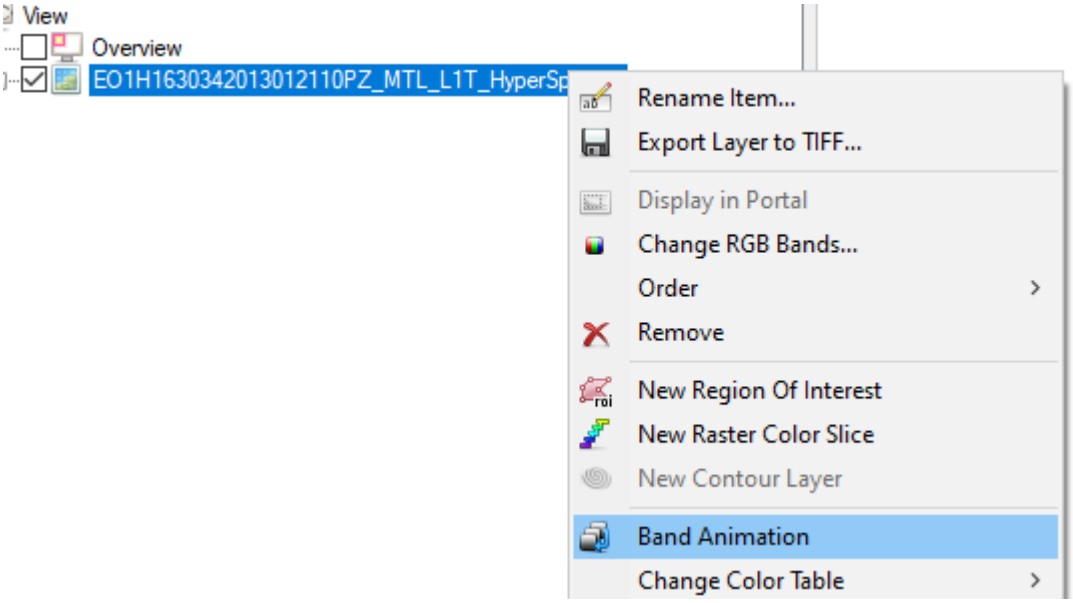
Acquisition Time:

We need the acquisition time later in FLAASH.

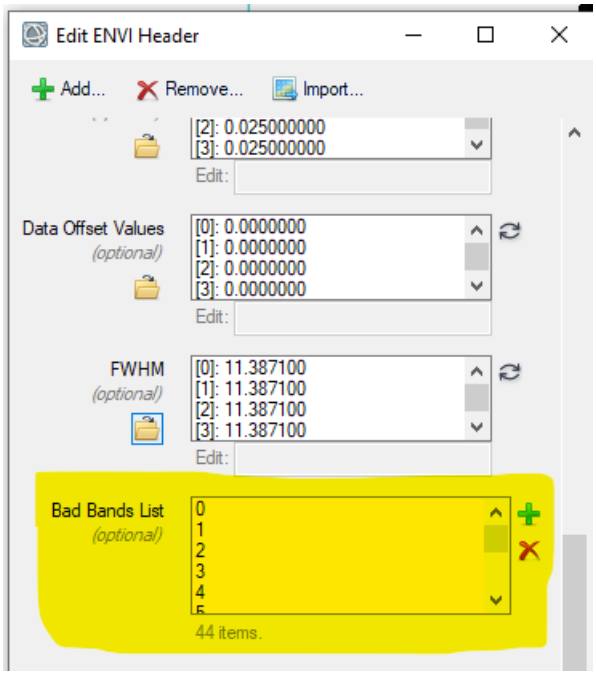




8-3 – Animate the Bands:



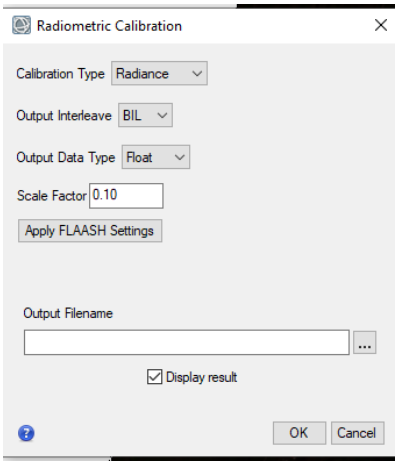
8-4 – Designate Bad Bands



8-5 Radiometric Calibration:

In the File Selection dialog, the file HyperionForest.dat is already selected. The Spectral Subset field shows 175 of 242 bands, which confirms that the bad bands have been recognized. Click OK.

In the Radiometric Calibration dialog, click Apply FLAASH Settings. This will create a band-interleaved-by-line (BIL) radiance image with floating-point values in the correct units needed for the FLAASH atmospheric correction tool.



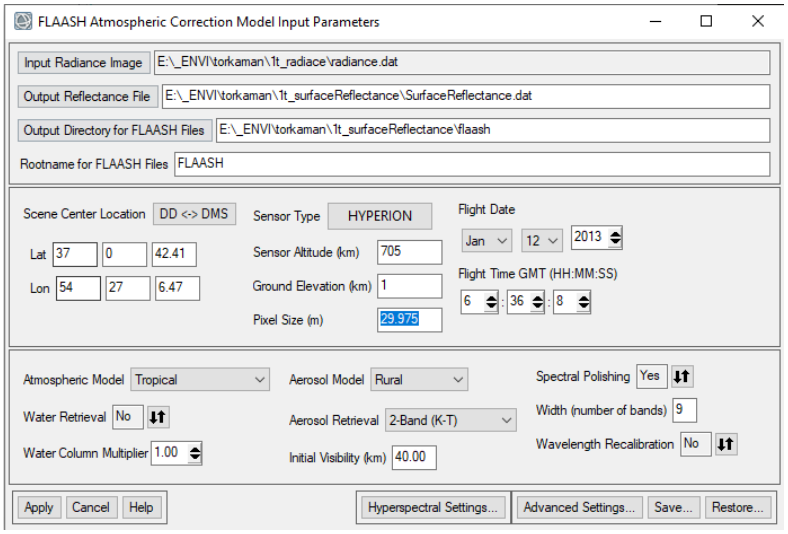
Note: Do not modify the Scale Factor field. The pixel values of HyperionForest.dat are in units of **W/(m2 * sr * µm).** The Radiometric Calibration tool will apply the gain values mentioned in the View Metadata section above, then it will multiply the pixel values by **0.1** so that they will be in units of **µW/(cm2 * sr * nm), which is required for input to FLAASH.**

8-6 – Atmospheric Correction

We use FLAASH.

Input Radiance Image button.

In the Radiance Scale Factors dialog, select the option Use single scale factor for all bands, and keep the default value of 1.0 for the Single scale factor. The Radiometric Calibration tool already applied the correct gain values and scale factors, so no further adjustments are needed here.



Moien Rangzan – moienrangzan@gmail.com

FLAASH automatically determines the scene's center geographic coordinates, so you do not need to enter these values

Select Atmospheric Model Options

So we have this table from FLAASH manual.

We know our date is in July

And latitude of area is 37

But, we know that north of iran is kinda tropical, so we choose T instead of MLS, but I'm not sure *(ask Dr. Abdollahi).*

Table 2-1: Column Water Vapor Amounts and Surface Temperatures for the MODTRAN Model Atmospheres (Continued)

Latitude (°N)	Jan.	March	May	July	Sept.	Nov.
80	SAW	SAW	SAW	MLW	MLW	SAW
70	SAW	SAW	MLW	MLW	MLW	SAW
60	MLW	MLW	MLW	SAS	SAS	MLW
50	MLW	MLW	SAS	SAS	SAS	SAS
40	SAS	SAS	SAS	MLS	MLS	SAS
30	MLS	MLS	MLS	T	T	MLS
20	T	T	T	T	T	T
10	T	T	T	T	T	T
0	T	T	T	T	T	T
-10	T	T	T	T	T	T
-20	T	T	T	MLS	MLS	T
-30	MLS	MLS	MLS	MLS	MLS	MLS
-40	SAS	SAS	SAS	SAS	SAS	SAS
-50	SAS	SAS	SAS	MLW	MLW	SAS
-60	MLW	MLW	MLW	MLW	MLW	MLW
-70	MLW	MLW	MLW	MLW	MLW	MLW
-80	MLW	MLW	MLW	SAW	MLW	MLW

Table 2-2: Selection of MODTRAN Model Atmospheres Based on Latitudinal/Seasonal Dependence of Surface Temperature

Click the Water Retrieval toggle button to select Yes.

Accept the default value of 1135 nm for Water Absorption Feature. If you select 1135 nm or 940 nm, and the feature is saturated due to an extremely wet atmosphere (unlikely for this location), then the 820 nm feature would be used in its place.

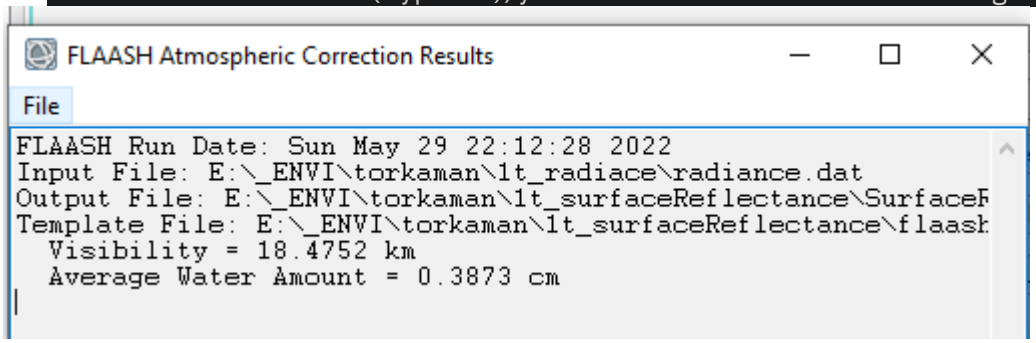
Using Water Retrieval

To solve the radiative transfer equations that allow apparent surface reflectance to be computed, the column water vapor amount for each pixel in the image must be determined. FLAASH includes a method for retrieving the water amount for each pixel. This technique produces a more accurate correction than using a constant water amount for the entire scene. To use this water retrieval method, the image must have bands that span at least one of the following ranges at a spectral resolution of 15 nm or better:

- 1050-1210 nm (for the 1135 nm water feature)
- 870-1020 nm (for the 940 nm water feature)
- 770-870 nm (for the 820 nm water feature)

Accept the default value of Rural for Aerosol Model. This is a good option for the location of our scene, where aerosols are not strongly affected by urban or industrial sources.

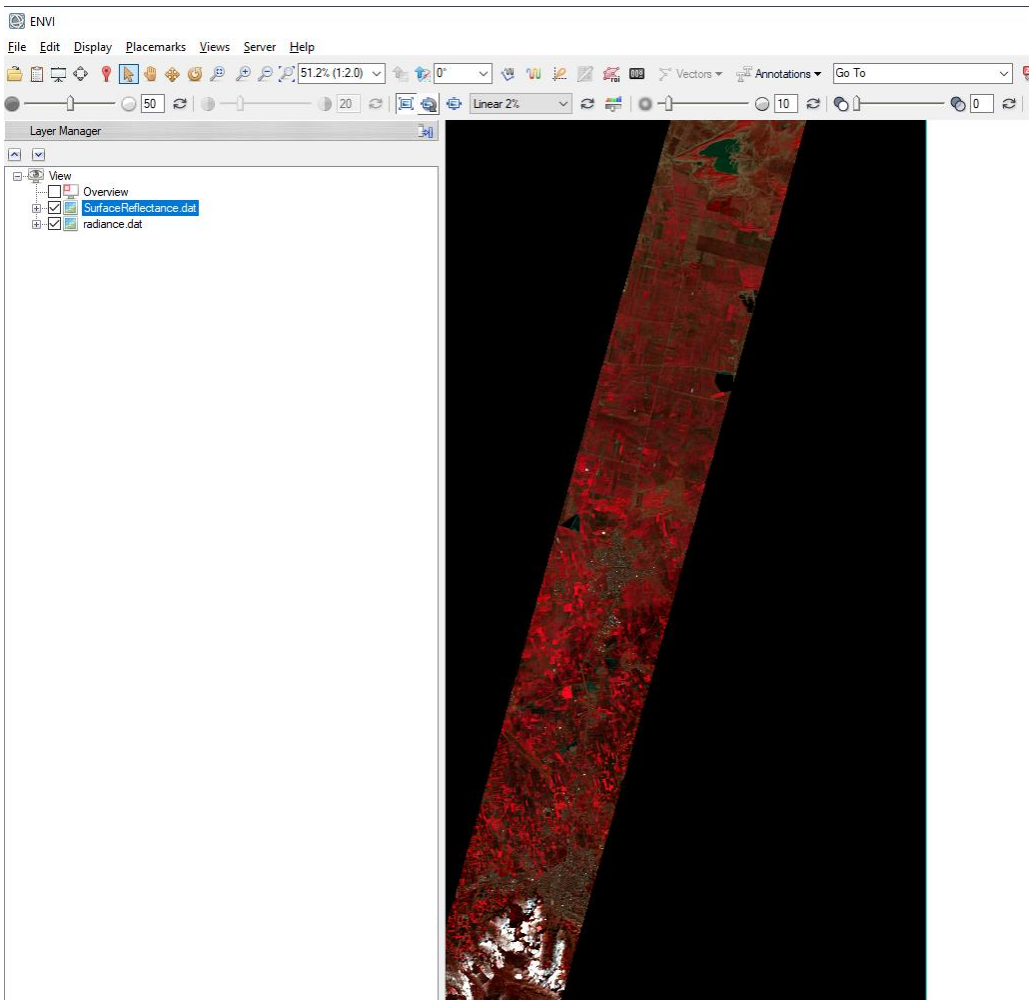
The settings available under the **Hyperspectral Settings** button at the bottom of the FLAASH dialog are only needed if you are working with a hyperspectral sensor that is not widely recognized. You would use these settings to choose how bands are selected for water vapor and/or aerosol retrieval. Since our data are from a named sensor (Hyperion), you do not need to define these settings.



- To load a true-color image, right-click on a filename in the Data Manager and select **Load True Color**. The image must have wavelengths defined for this option to be available. ENVI defines true color as the smallest difference in the wavelength values closest to red as 0.64 µm, green as 0.55 µm, and blue as 0.47 µm.

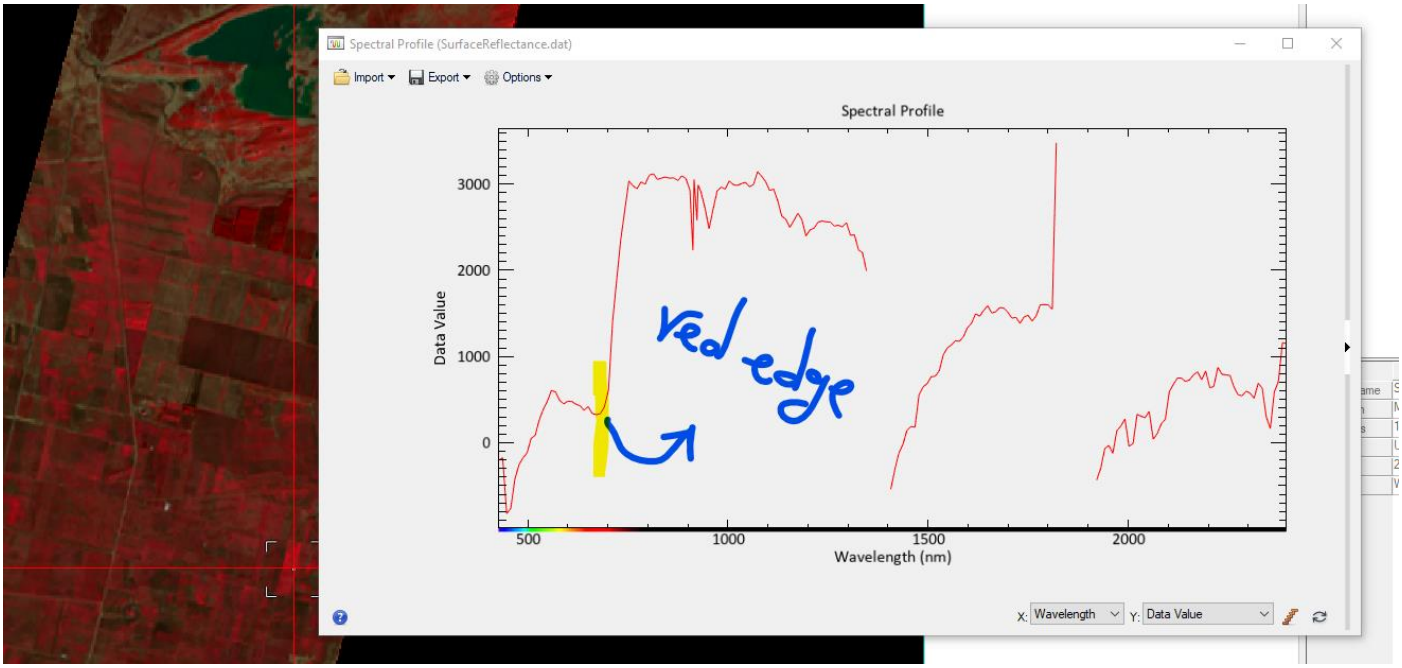
- To load a color-infrared (CIR) image, right-click on a filename in the Data Manager and select **Load CIR**. The image must have wavelengths defined for this option to be available.

Open the Data Manager and scroll down to `SurfaceReflectance.dat`. Right-click on its filename and select **Load CIR**. The image displays in a false-color combination. The following figure shows an example of the northern part of the image:



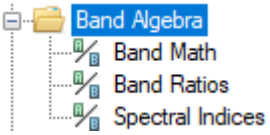
Spectral Profile:

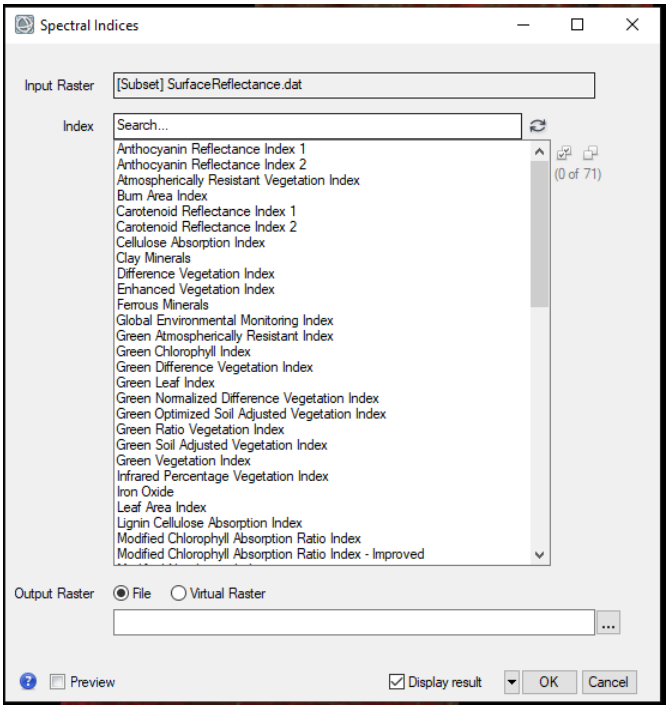
Click  and choose a pixel



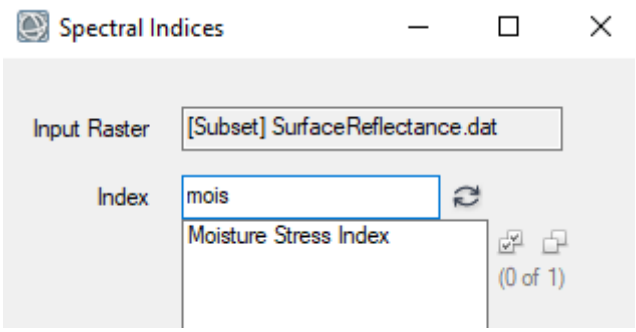
8-7 –Spectral Indices:

In the spectral indices you find a lot of usful indices





Moisture stress index

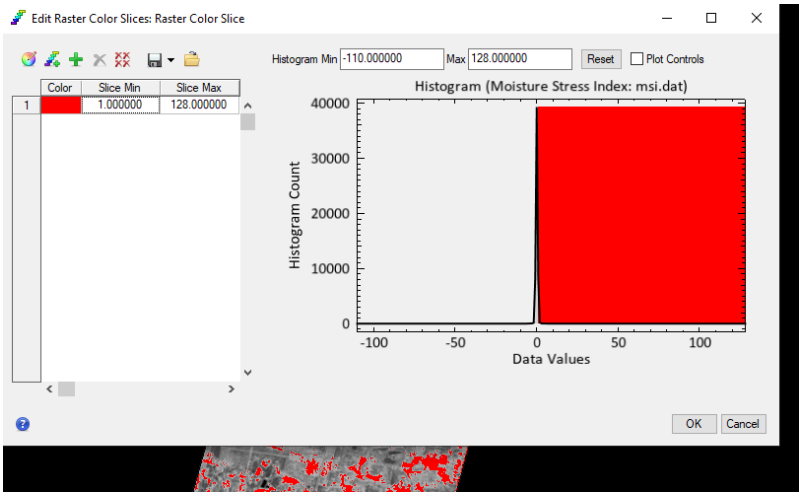


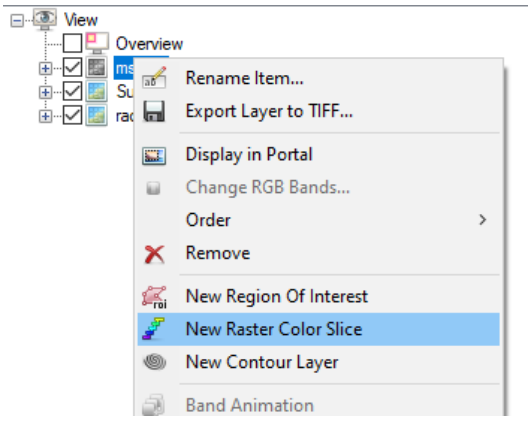
Brighter pixel values indicate more water deficiency. The Moisture Stress Index is a reflectance measurement that is sensitive to increasing leaf water content. As the water content in vegetation increases, the strength of the absorption around 1599 nm increases. Absorption at 819 nm is nearly unaffected by changing water content, so it is used as the reference wavelength (Hunt, Jr. and Rock, 1989)

$$MSI = \frac{\rho_{1599}}{\rho_{819}}$$

Moien Rangzan – moienrangzan@gmail.com

Raster Color Slices:





Right-click on the Slices folder in the Layer Manager and select Export Color Slices > Shapefile.

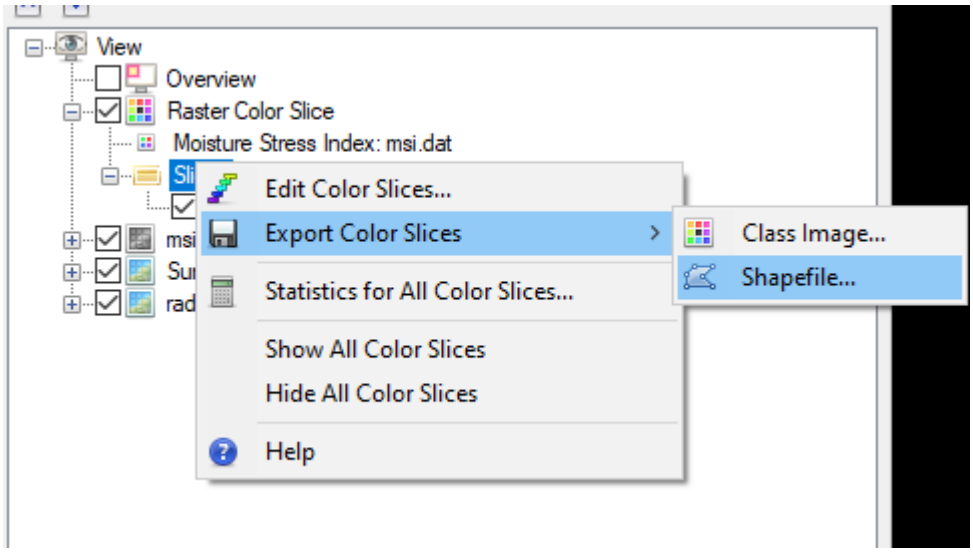
Enter an output filename of HighMSI.shp, and click OK.

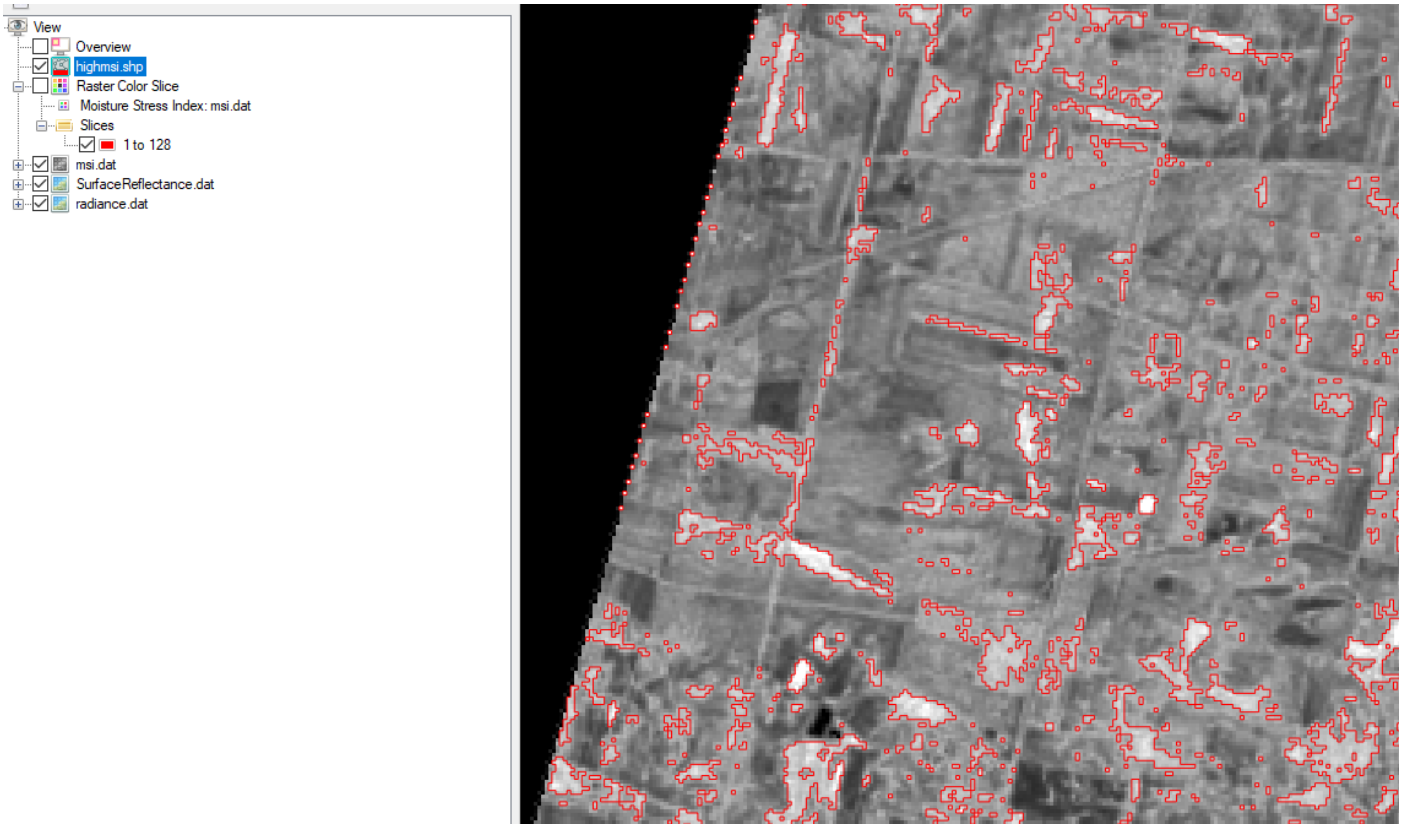
Wait for the ExportVector process to complete in the Process Manager, then click OK to exit the Edit Raster Color Slices dialog.

Un-check the MSI.dat layer in the Layer Manager to hide that layer. The red raster color slice is displayed on top of the original surface reflectance image.

Highlight the Raster Color Slice layer in the Layer Manager, then adjust the Transparency slider in the toolbar to see through the color slice to the surface reflectance image underneath.

Un-check the Raster Color Slice layer to hide it.





8-52 - Spectral profile compare

8-53 – AVRIS preprocessing

8-55 – SAM and SFF

Spectral angle mapper

Spectral feature fitting

These are to classify images based on their spectral profile compared to known spectral profiles

9-Moien's Perfect Notes:

9-1 - A comprehensive guide to Radiometric and Atmospheric Correction:

9-1-1 – How does ENVI do Radiometric correction (calibration)?

In this ENVI doc for radiometric correction you can find these formulas for **Reflectance and Radiance** *(what is the difference between these two? Read 9-1-3)*

- **Radiance:** This option is available if the image has gains and offsets for each band. ENVI reads these values from metadata from the sensors listed above. Radiance is computed using the following equation:

$$L_\lambda = Gain * Pixel\ value + Offset$$

ENVI expects gains and offsets to be in units of W/(m^2 * sr * µm). If so, then radiance will be in units of W/(m^2 * sr * µm).

- **Reflectance:** Top-of-atmosphere (TOA) reflectance (0 to 1.0). This option is available if the image has gains, offsets, solar irradiance, sun elevation, *and* acquisition time defined in the metadata. ENVI reads these values from metadata from the sensors listed above.

  If the input file contains metadata for reflectance gains and offsets, ENVI uses those values to calibrate the data to TOA reflectance. With Landsat-8 files, ENVI scales the reflectance gains and offsets by the sine of the sun elevation.

  If the input file does not contain metadata for reflectance gains and offsets, ENVI computes TOA reflectance using the following equation:

  $$\rho_\lambda = \frac{\pi L_\lambda d^2}{ESUN_\lambda \sin\theta}$$

  Where:

  L_λ = Radiance in units of W/(m^2 * sr * µm)

  d = Earth-sun distance, in astronomical units.

  $ESUN_\lambda$ = Solar irradiance in units of W/(m^2 * µm)

  θ = Sun elevation in degrees

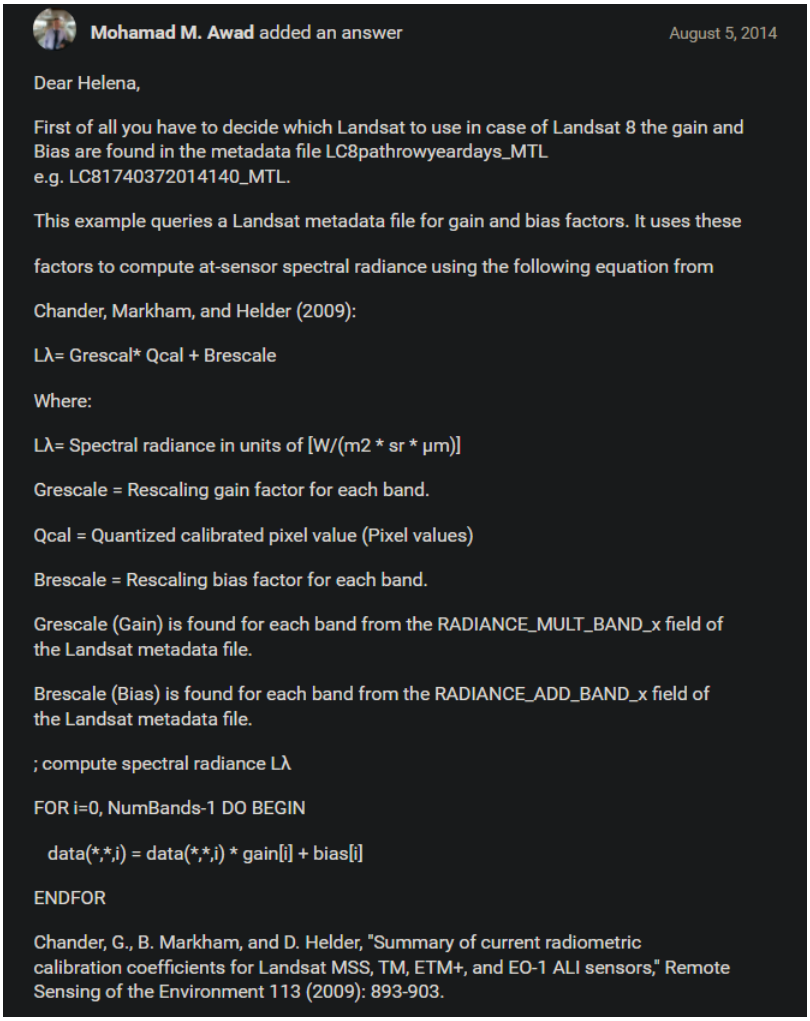
9-1-2 - Where can you find these data (offset and gain)?

https://www.researchgate.net/post/Where-exactly-in-Landsat-metadata-could-I-find-gain-and-bias

in the link above, you can learn where to find the arguments of the 9-1-1 equations

Grescale (Gain) is found for each band from the RADIANCE_MULT_BAND_x field of the Landsat metadata file.

Brescale (Bias) is found for each band from the RADIANCE_ADD_BAND_x field of the Landsat metadata file.



Mohamad M. Awad added an answer — August 5, 2014

Dear Helena,

First of all you have to decide which Landsat to use in case of Landsat 8 the gain and Bias are found in the metadata file LC8pathrowyeardays_MTL
e.g. LC81740372014140_MTL.

This example queries a Landsat metadata file for gain and bias factors. It uses these

factors to compute at-sensor spectral radiance using the following equation from

Chander, Markham, and Helder (2009):

Lλ= Grescal* Qcal + Brescale

Where:

Lλ= Spectral radiance in units of [W/(m2 * sr * µm)]

Grescale = Rescaling gain factor for each band.

Qcal = Quantized calibrated pixel value (Pixel values)

Brescale = Rescaling bias factor for each band.

Grescale (Gain) is found for each band from the RADIANCE_MULT_BAND_x field of the Landsat metadata file.

Brescale (Bias) is found for each band from the RADIANCE_ADD_BAND_x field of the Landsat metadata file.

; compute spectral radiance Lλ

```
FOR i=0, NumBands-1 DO BEGIN

  data(*,*,i) = data(*,*,i) * gain[i] + bias[i]

ENDFOR
```

Chander, G., B. Markham, and D. Helder, "Summary of current radiometric calibration coefficients for Landsat MSS, TM, ETM+, and EO-1 ALI sensors," Remote Sensing of the Environment 113 (2009): 893-903.

9-1-3 – what is the difference between reflectance and radiance?

https://www.l3harrisgeospatial.com/ReflectanceVsRadiance

Radiance is the variable directly measured by remote sensing instruments. Basically, you can think of radiance as how much light the instrument "sees" from the object being observed. When looking through an atmosphere, some light scattered by the atmosphere will be seen by the instrument and included in the observed radiance of the target. An atmosphere will also absorb light, which will decrease the observed radiance. Radiance most often has units of watt/(steradian/square meter).

Reflectance is the ratio of the amount of light leaving a target to the amount of light striking the target. It has no units. If all of the light leaving the target is intercepted for the measurement of reflectance, the result is called "hemispherical reflectance."

Reflectance (or more specifically hemispherical reflectance) is a property of the material being observed. Radiance, on the other hand, depends on the illumination (both its intensity and direction), the orientation and position of the target and the path of the light through the atmophere. With effort, many of the atmospheric effects and the solar illumination can be compensated for in remote sensing data. This yields something which is called "apparent reflectance," and it differs from true reflectance in that shadows and directional effects on reflectance have not been dealt with. Many people refer to this as "reflectance."

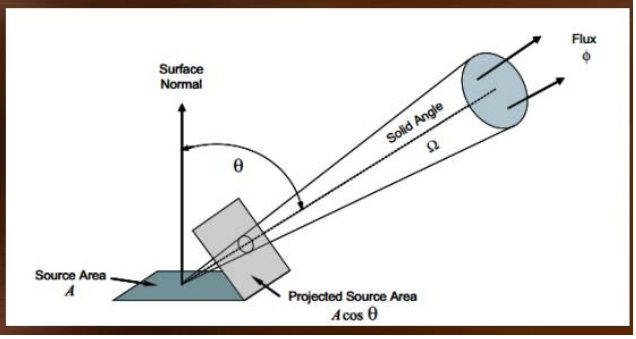
For many applications, radiance, reflectance, and apparent reflectance can be used interchangibly. However, since reflectance is a property of the target material itself, you will get the most reliable (and repeatable) vegetation index values using reflectance. Apparent reflectance is adequate in many cases.

Nomenclature and Definition of Radiation Quantities

- Radiance (brightness - L - Watt/steradian m^2)
  - The radiant flux per unit solid angle leaving an extended source in a given direction per unit projected area in that direction.
  - Function of both position and direction

$$L = L(x, y, \theta, \phi) = \frac{\mathrm{d}^2\Phi}{\mathrm{d}A \cos\theta \, \mathrm{d}\Omega}$$

$$L = L(x, y, \theta, \phi) = \frac{\mathrm{d}^2\Phi}{\mathrm{d}A \cos\theta \, \mathrm{d}\Omega} = \frac{\mathrm{d}E}{\mathrm{d}\Omega \cos\theta} = \frac{\mathrm{d}I}{\mathrm{d}A \cos\theta} = \frac{\mathrm{d}M}{\mathrm{d}\Omega \cos\theta}$$



Majid Kiavarz

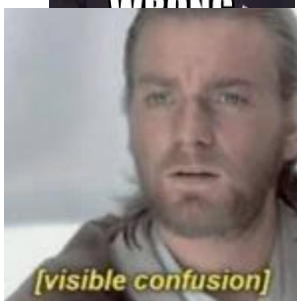
9-2 Dark object atmospheric correction:
https://www.youtube.com/watch?v=DxeiP4b9OxE

There must be an object in the scene which is the perfect black and must not have any reflection, but we don't get zero pixels which means that there was a distortion that made the lowest pixel be more than zero, so if we subtract the lowest pixel value (in histogram we choose the darkest pixel with the abundance of about 1%), we are removing this atmospheric effect.

9-3 Aster radiometric and atmospheric correction

ASTER L1T stands for: *ASTER Level 1 Precision Terrain Correction Registered At-Sensor Radiance (AST_L1T) products.*

From the name, we can infer that it is at sensor radiance, and we do not need to do Radiometric correction, right? WRONG!



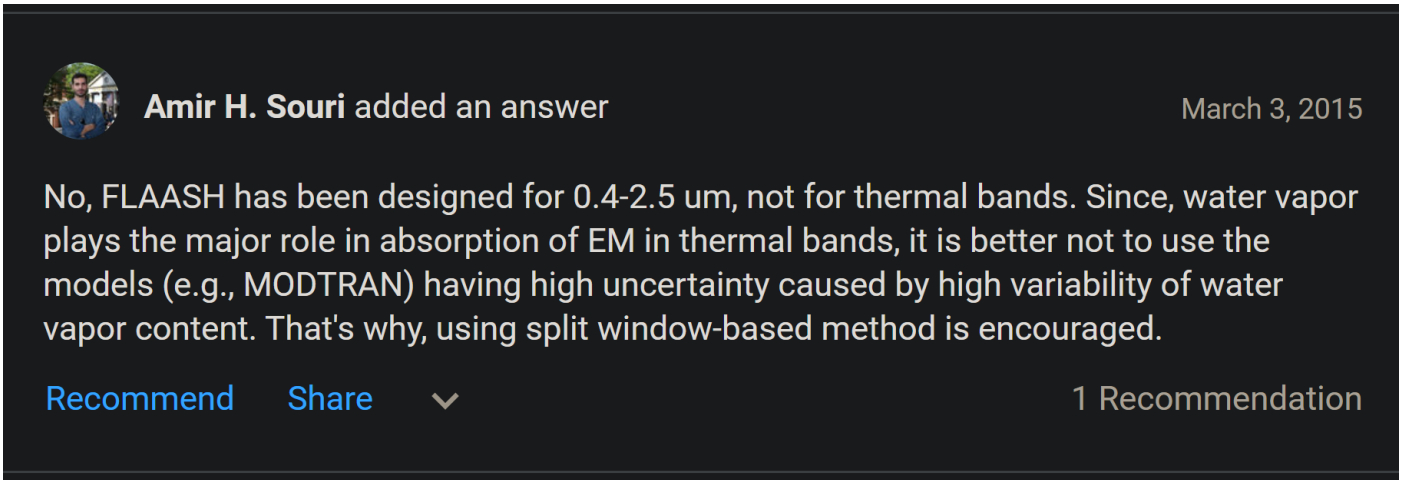
Further in L1T handbook, we can read this on page47:

"Radiance is converted to DN values taking into account both the acquisition gain settings and the gain calibration included within the radiometric database."

SO DO BOTH RADIO AND ATMO CORRECTIONS!

Moien Rangzan – moienrangzan@gmail.com

9-4 – FLAASH (MODTRAN model) can not be used on thermal bands



Amir H. Souri added an answer — March 3, 2015

No, FLAASH has been designed for 0.4-2.5 um, not for thermal bands. Since, water vapor plays the major role in absorption of EM in thermal bands, it is better not to use the models (e.g., MODTRAN) having high uncertainty caused by high variability of water vapor content. That's why, using split window-based method is encouraged.

Recommend Share — 1 Recommendation

9-5 – ASTER mineral project: youtube.com/aster_mineral

Steps:

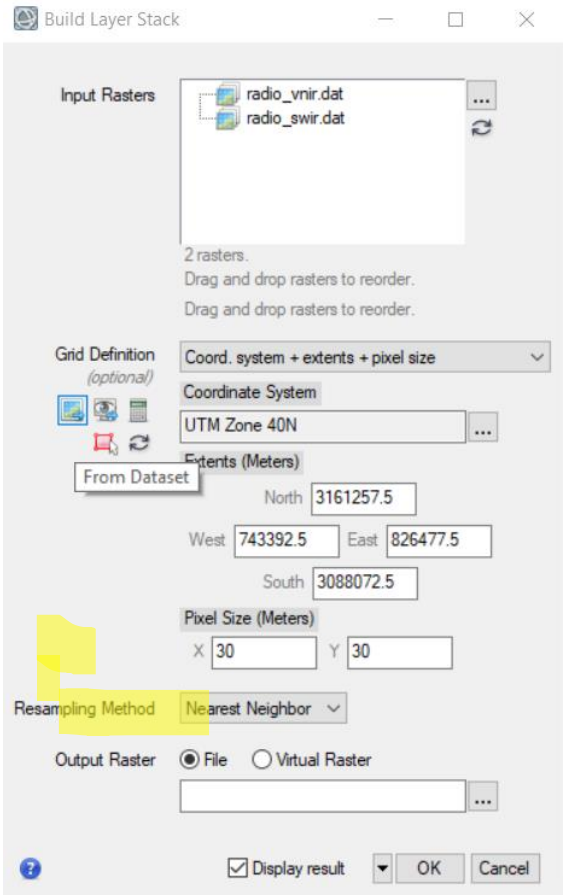
1. *radiometric correction for: VNIR,SWIR,TIR*
2. *stack VNIR-SWIR*
3. *atmospheric VNIR-SWIR using QUAC*
4. *bandmath to normalize data*
5. *thermal atmospheric*

9-5-2 – Build layer stack (layer stacking)

When you added you layers to the tool, the tool asks you to fill in the lower part, if you want to fill it with original data, click *'from dataset'*

After that you can change, anything you want, for example pixel size

Note that you cant only feel pixel size and live the rest empty, casue you'll get an error.



9-5-2 Unmixing linear

To do this we need **at least** two spectral files

You can go to your map choose **z profile** or and choose a pixel then save the spectral profiles

Or you can go to enci usgs library and save two profiles from there.

9-5-3 – band math and normalizing:

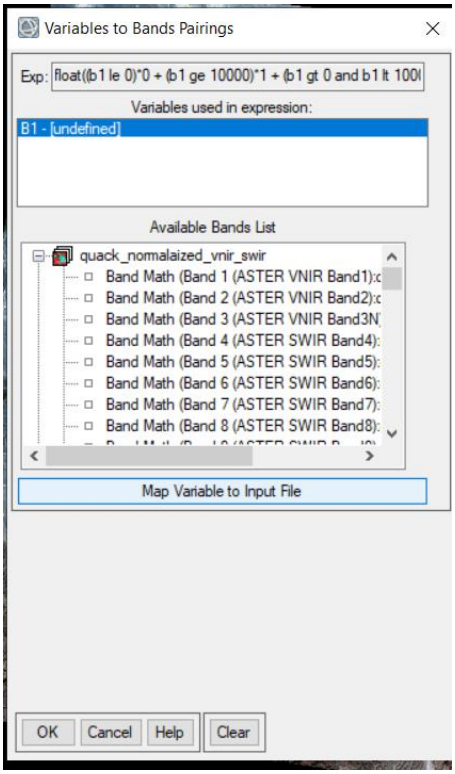
We use this expression:

*float((b1 le 0)*0 + (b1 ge 10000)*1 + (b1 gt 0 and b1 lt 10000)*float(b1/10000.0))*

less than 0 => 0

greater than 1000 => 1

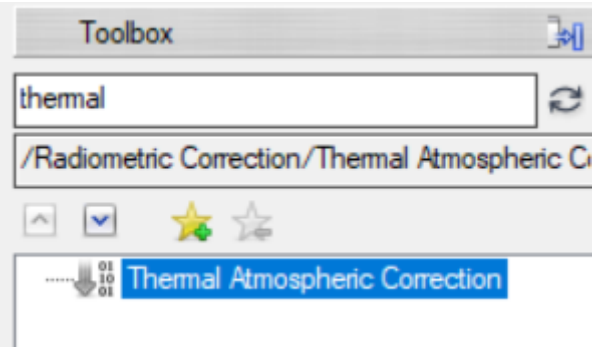
between zero and 1000 => normalize by 1000



we use ‘map variable to input file’ to apply the math to all the bands all at once

9-5-4 thermal atmospheric

We have a tool explicitly for theram atmospheric, we do this after radiometric

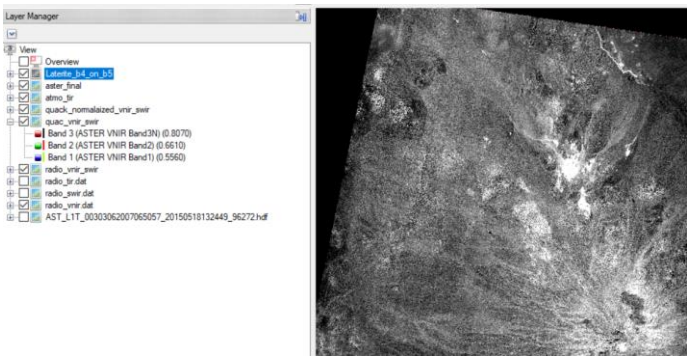


Feature	Band or Ratio	Comments	Reference
Iron			
Ferric iron, Fe^{3+}	2/1		Rowan; CSIRO
Ferrous iron, Fe^{2+}	5/3 + 1/2		Rowan
Laterite	4/5		Bierwith
Gossan	4/2		Volesky
Ferrous silicates (biot, chl, amph)	5/4	Fe oxide Cu-Au alteration	CSIRO
Ferric oxides	4/3	Can be ambiguous*	CSIRO
Carbonates / Mafic Minerals			
Carbonate / chlorite / epidote	(7+9)/8		Rowan
Epidote / chlorite / amphibole	(6+9)/(7+8)	Endoskarn	CSIRO
Amphibole / MgOH	(6+9)/8	Can be either MgOH or carbonate*	Hewson
Amphibole	6/8		Bierwith
Dolomite	(6+8)/7		Rowan, USGS
Carbonate	13/14	Exoskarn (cal/dolom)	Bierwith, Nimoyima, CSIRO
Silicates			
Sericite / muscovite / illite / smectite	(5+7)/6	Phyllic alteration	Rowan (USGS); Hewson (CSIRO)
Alunite / kaolinite / pyrophyllite	(4+6)/5		Rowan (USGS)
Phengitic	5/6		Hewson
Muscovite	7/6		Hewson
Kaolinite	7/5	Approximate only*	Hewson
Clay	$(5x7)/6^2$		Bierwith
Alteration	4/5		Volesky
Host rock	5/6		Volesky
Silica			
Quartz rich rocks	14/12		Rowan
Silica	(11x11)/10/12		Bierwith
Basic degree index (gnt, cpx, epi, chl)	12/13	Exoskarn (gnt, px)	Bierwith, CSIRO
SiO2	13/12	Same as 14/12	Palomera
SiO_2	12/13		Nimoyima
Siliceous rocks	(11x11)/(10x12)		Nimoyima
Silica	11/10		CSIRO
Silica	11/12		CSIRO
Silica	13/10		CSIRO
Other			
Vegetation	3/2		
NDVI	(3-2)/(3+2)	Normalised difference vegetation index	

9-5-5 – band ratios:

From GA7833.pdf you can find so many usfull stuff from ASTER, for example band ratios to find minerals:

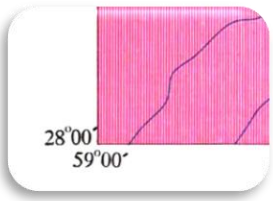
For example to find **Laterite** we use *b4/b5*

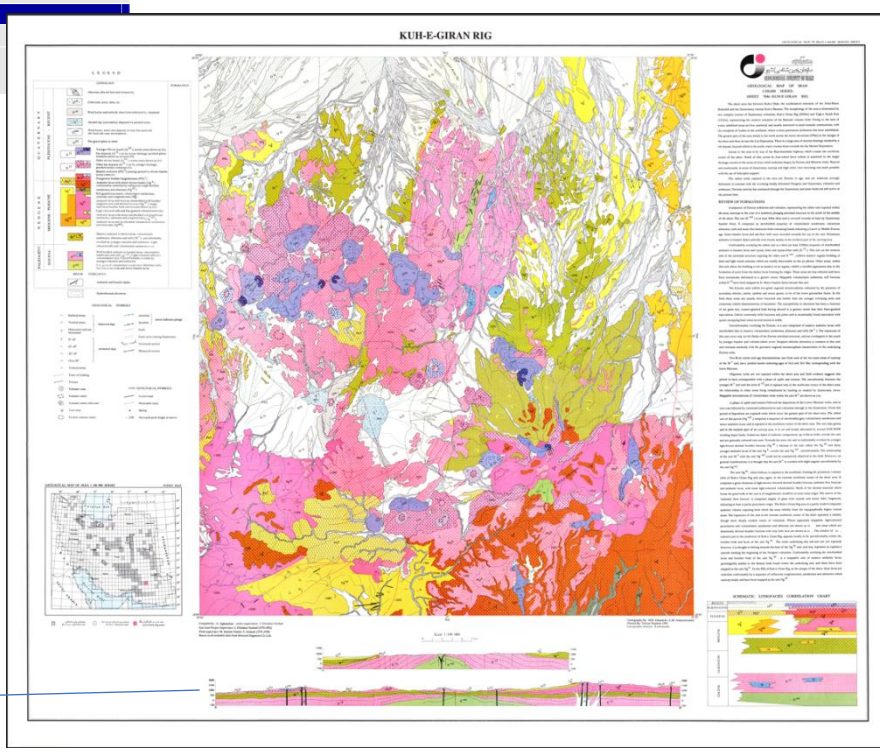


9-6 – Grace project

9-6-1 georefrencging the Geological Map:

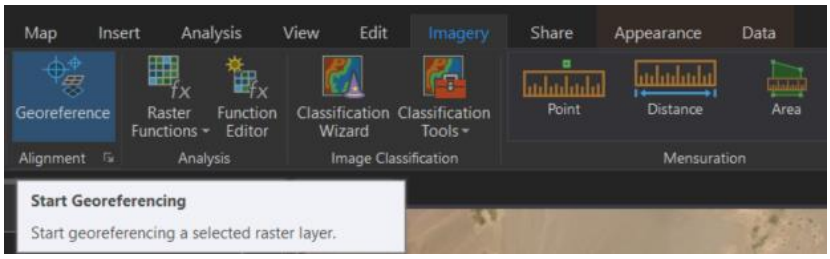
So the map is in jpg format and obviously does not have geo coding, we can do the georefrencing in ENVI using [Image reggistration workflow]
BUT! It is really hard, on the other hand we can use arcgis to do this, it is easy to use, and has online basemap that we can use to check whether we did everything right or not.

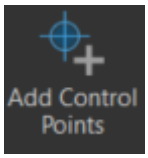




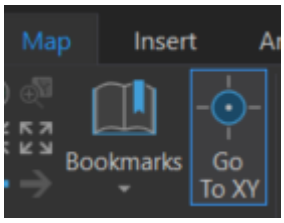
Moien Rangzan – moienrangzan@gmail.com

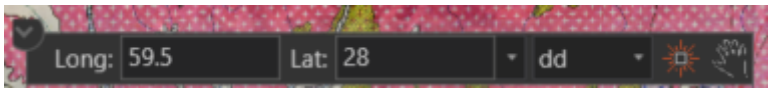
- Import the image and select a proper base map (I chose satellite imagry basemap.)
- Select the image and in the imagry tab click – **Georefrence**.
- You can see at each corner we have coordinates.



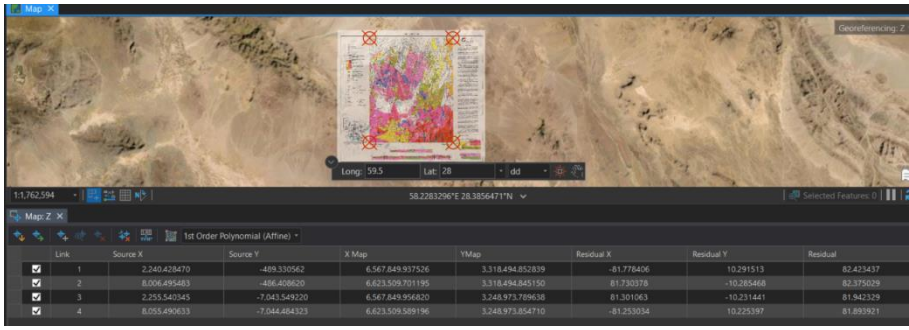
- Click 

- Click on that corner once.
- In map tab, choose, GO TO XY





- Choose the respective coordinate and select **pan to** (after that you can use flash button to show the point)



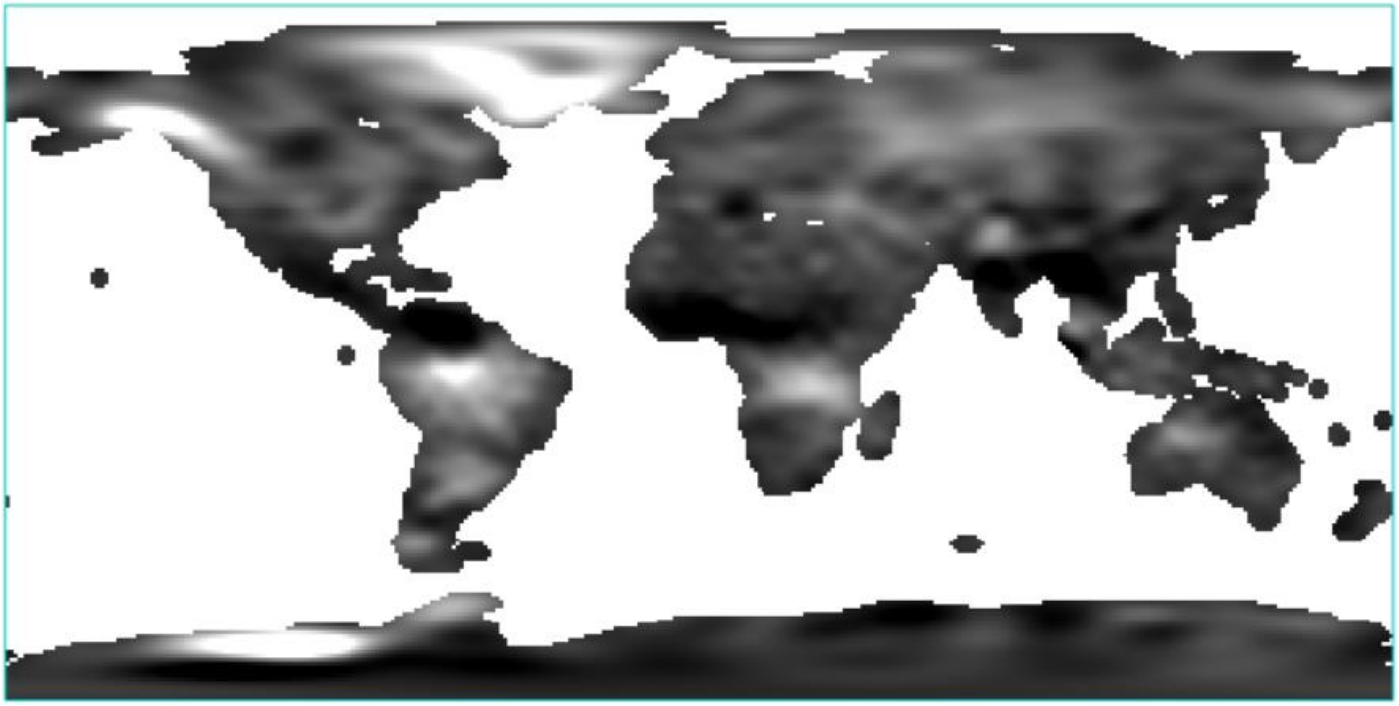
- Now you can click on the new point – do it for each point
- There you go! You have a georeferenced map!

9-6-2 – Download GRACE data:
https://podaac-tools.jpl.nasa.gov/drive/files/allData/tellus/L3/grace/land_mass/RL06/

https://podaac-tools.jpl.nasa.gov/drive/files/allData/tellus/L3/grace/land_mass/RL06/v04/JPL

use the links above, you'll need eath data account (same as earth exploerer)

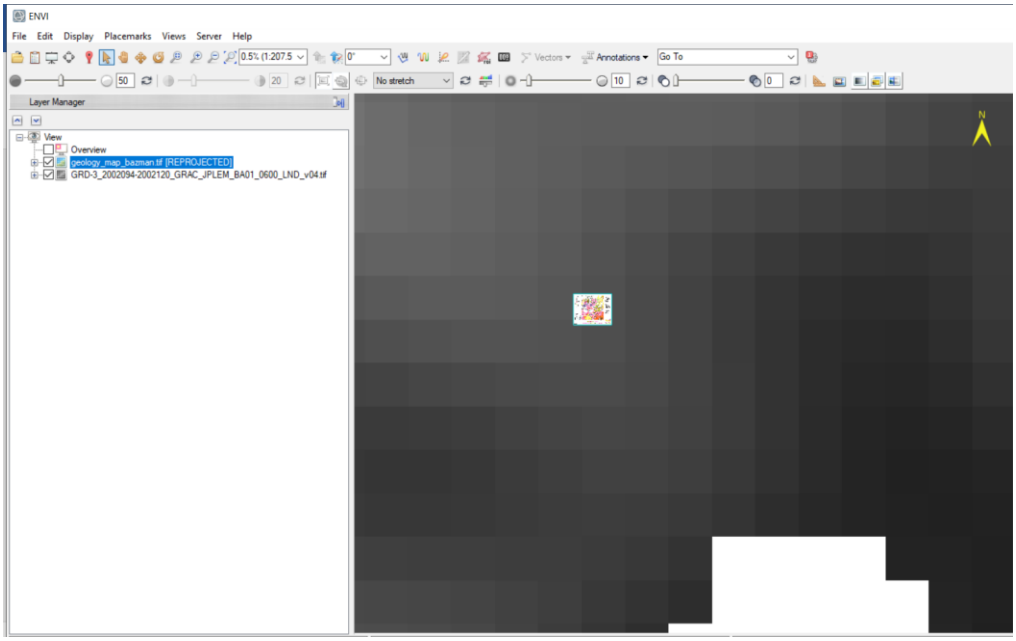
Moien Rangzan – moienrangzan@gmail.com



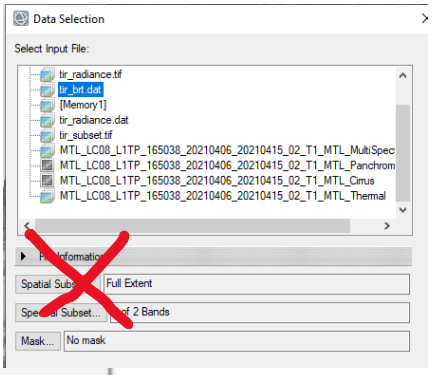
9-6-3 – Use it on our geology maap

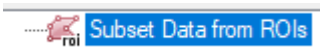
Well, it doesn't seem like the best Idea :))))

Our map doesn't even fit into one pixel, so I don't think there is anything to infer form.



9-7 – Subseting and Exporting as TIFF important notes



First do your corrections then apply 

Don't use spatial subset – it will subset the image but the image size wont chane for example your landsat scnse still would be 7000x7000 but all those pixels are null which will lead to huge size of dta after exporting .

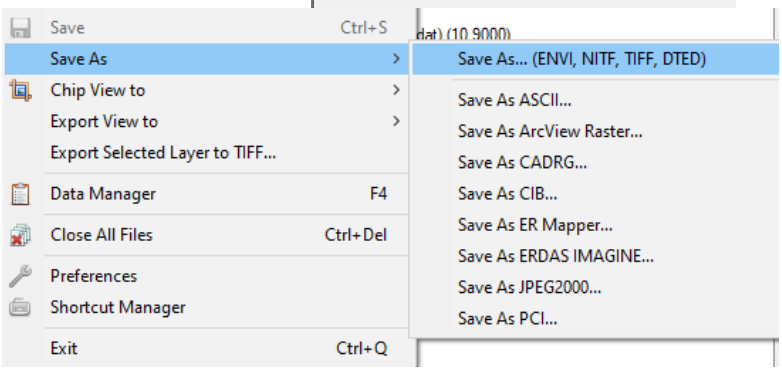
How to export files as TIFF?

Use Save As – "Don't use export selecet…"

Casue it would give you and 8bit RGB image.

Not matter how many bands you add.

Instead use "save as" and then choose TIFF.



How to export ROIs as Shapefile?

Click on  then File -> export -> shapefile