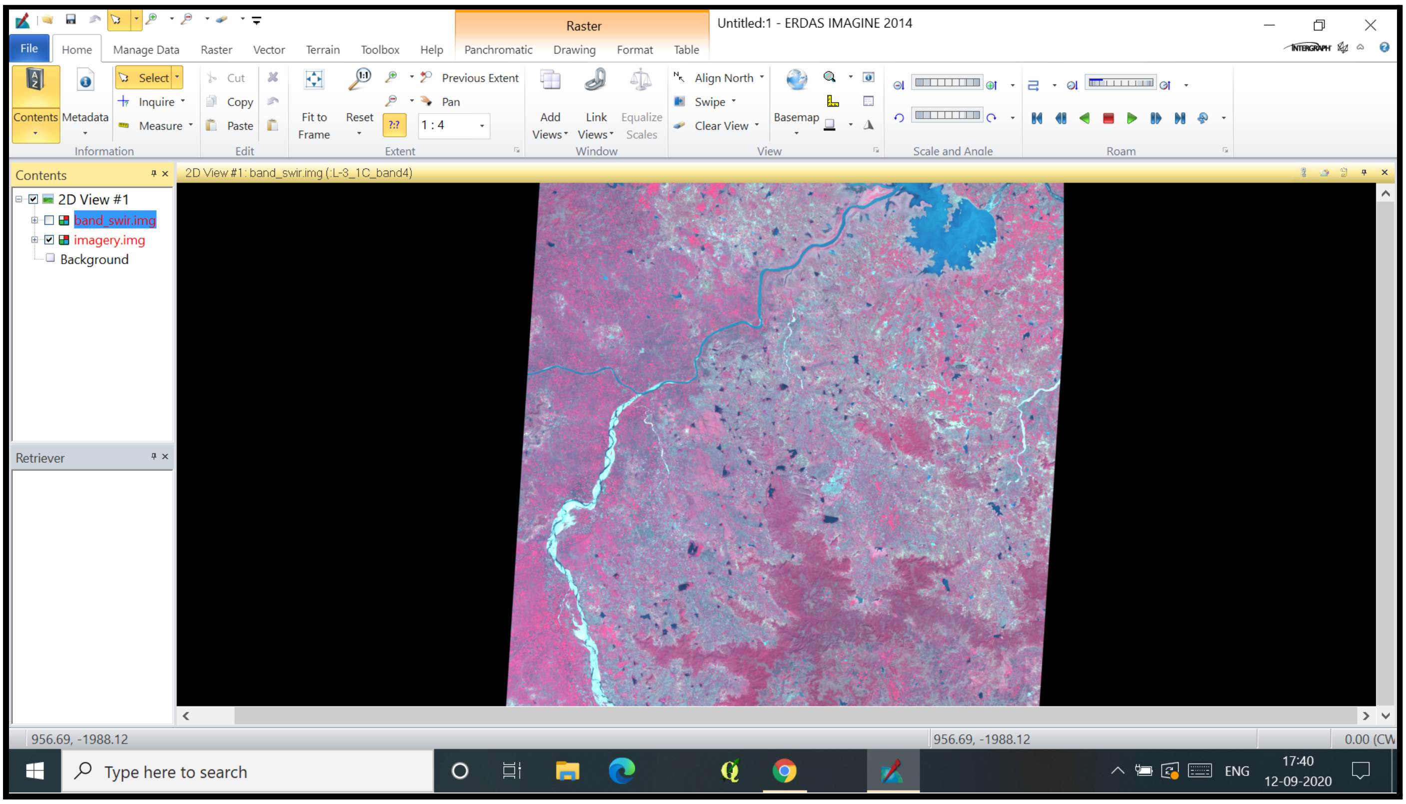
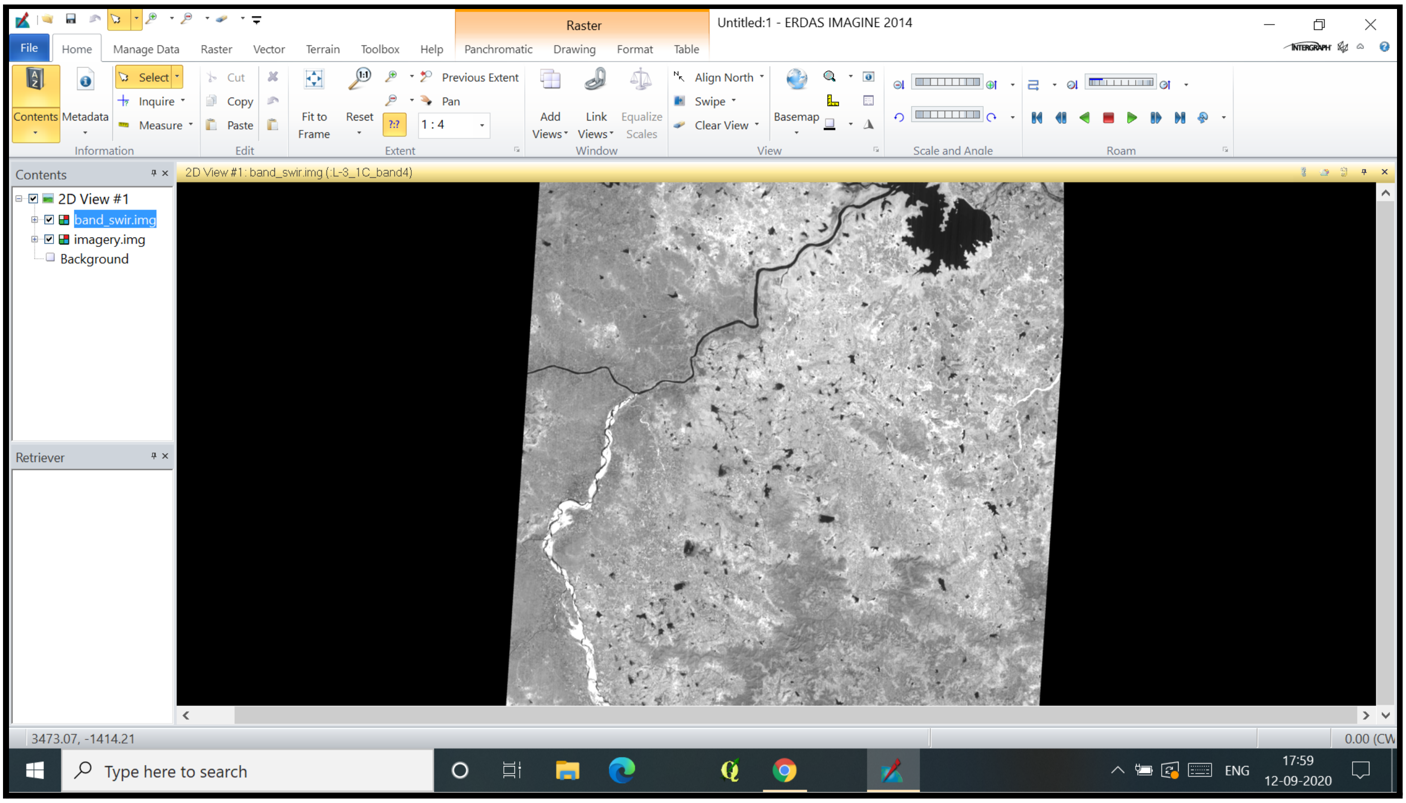
PART-1A

DISPLAY BADLINES IN LISS III IMAGES IN SWIR BAND

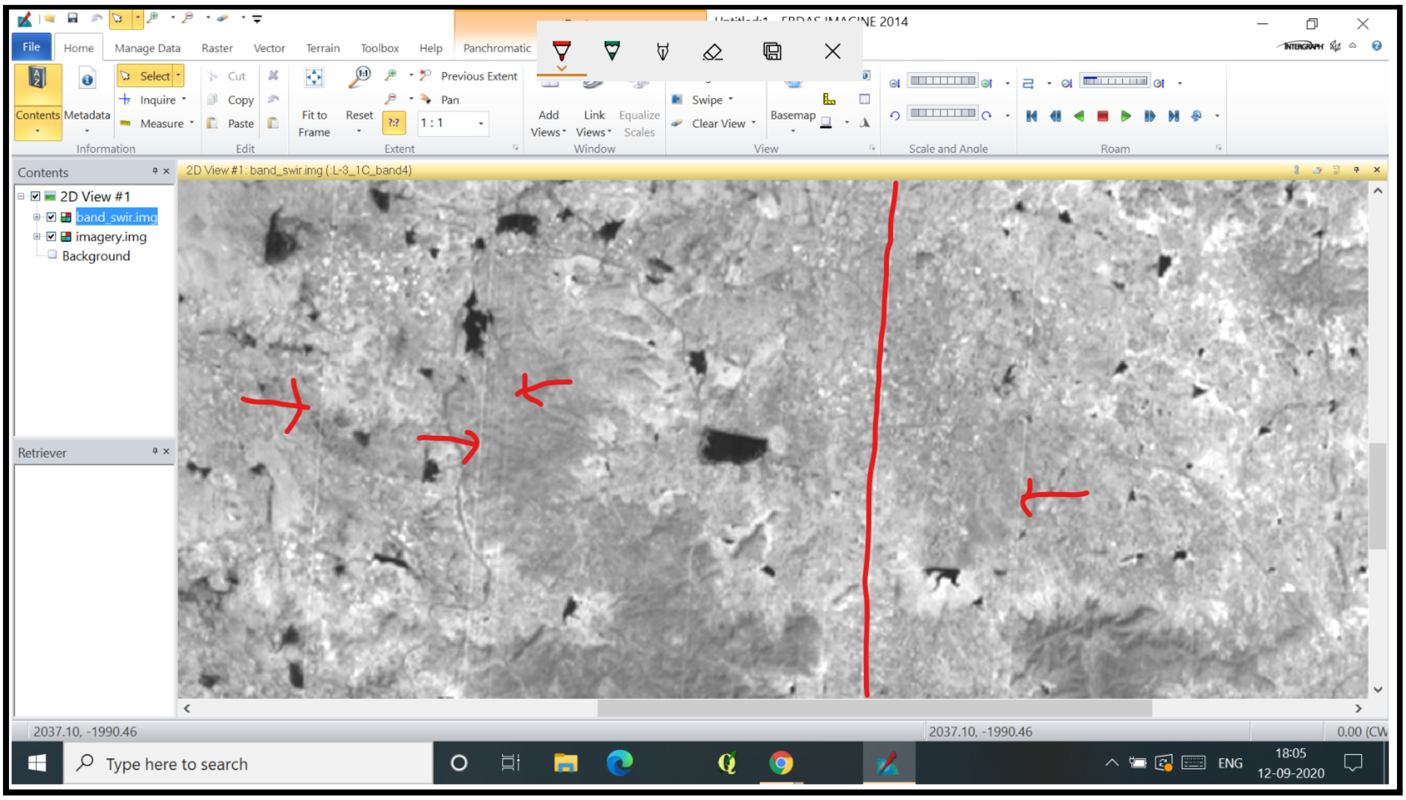
<u>Step 1:</u> Display the image in standard FCC (Green, Red and NIR bands stacked together) and can see a lot of **haze** in the data (image displayed)



<u>Step 2:</u> Open the swir band image.



Step 3- Zoom in to see the bad lines. Bad lines are visible in SWIR band because it has **poor resolution** and the line is tilted because of **earth's rotation i.e. SKEWED ERROR (scan line shift)**



As in this case, there is **no pattern of bad lines**. Therefore, it is difficult to rectify. Firstly, **identify the exact line no.** which has the error but it is difficult to identify because lines are tilted due to earth's rotation i.e **Skewed error.** So, to run the program, firstly identify those lines (line no. decreases downwards because of tilt) and **what is the shift for the next line**. Identify the particular pixels on which error is there and then identify the pixel value on left and pixel value on right and take their **average value.**

PART-1B

In built Rectification Program in Erdas Imagine

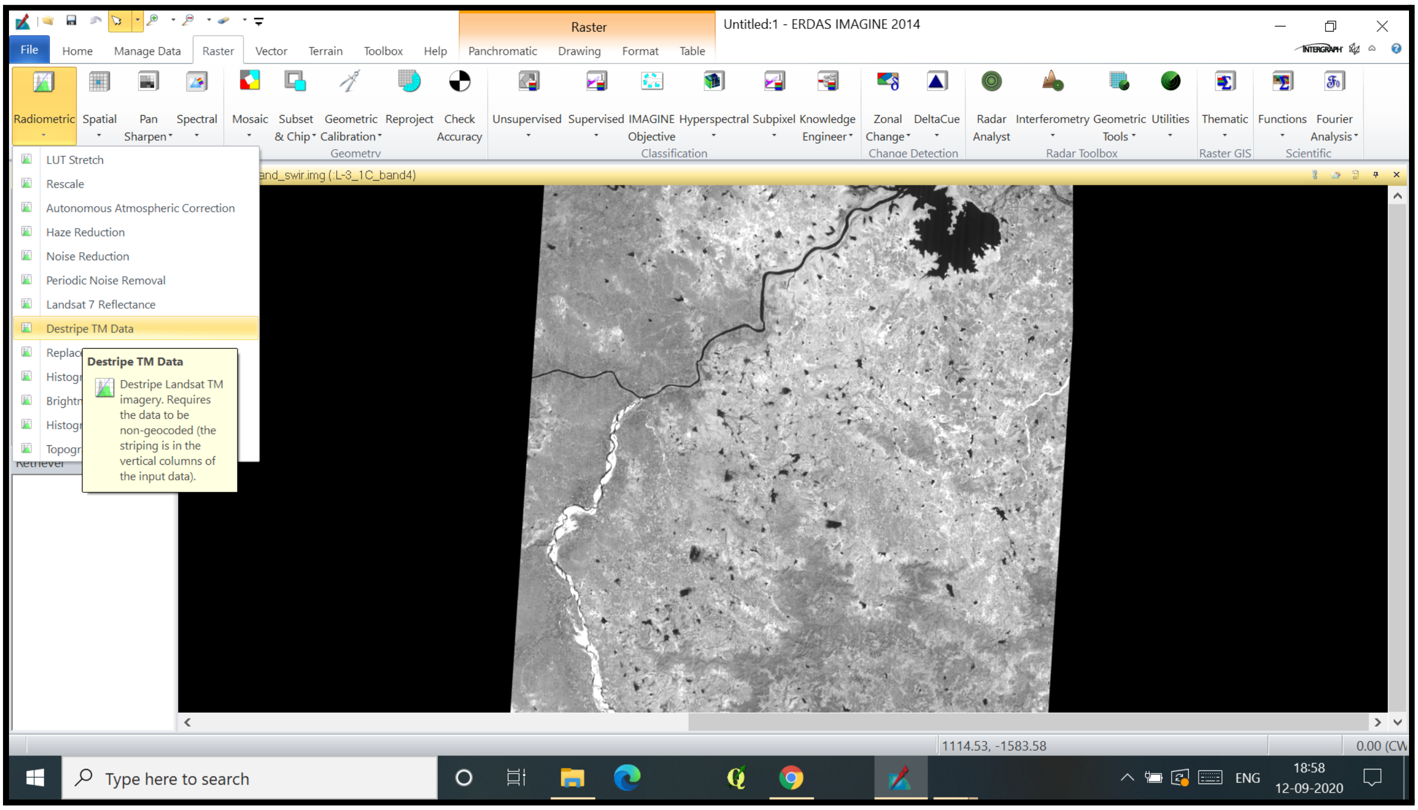
Destripe TM Data

Step-1: To go **Raster > Radiometric > Destripe TM Data**

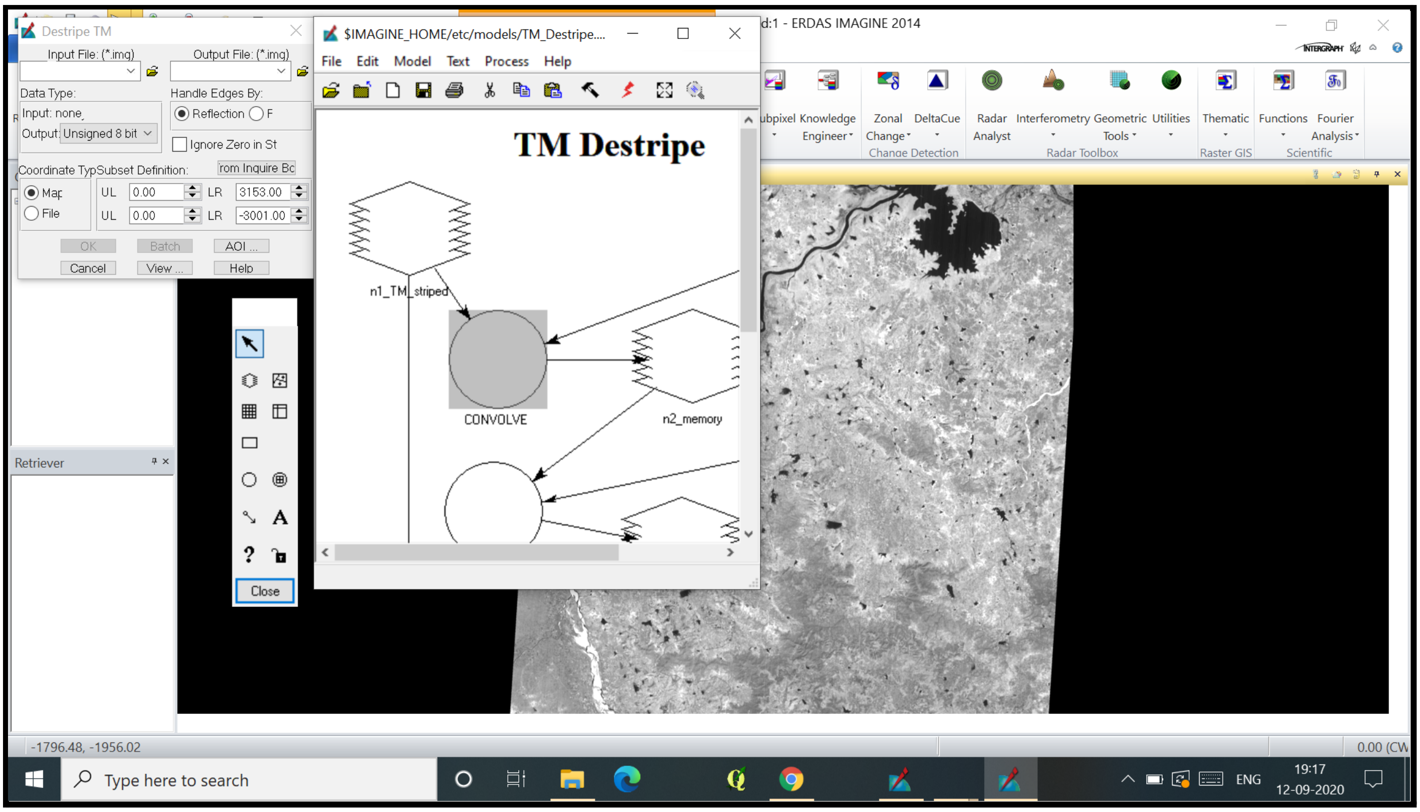
Prerequisite for Destripe TM Data-

- Data should not be geocoded
- Striping is in the vertical column of the input data.

In the above image, it is not geocoded, so the first condition is met but the strips are tilted i.e. they are **not vertical as skew error is already rectified.** So, we **can't do further processing.**



Step 2: **If the above conditions are met then we could have rectified using Destripe TM Data tool.**

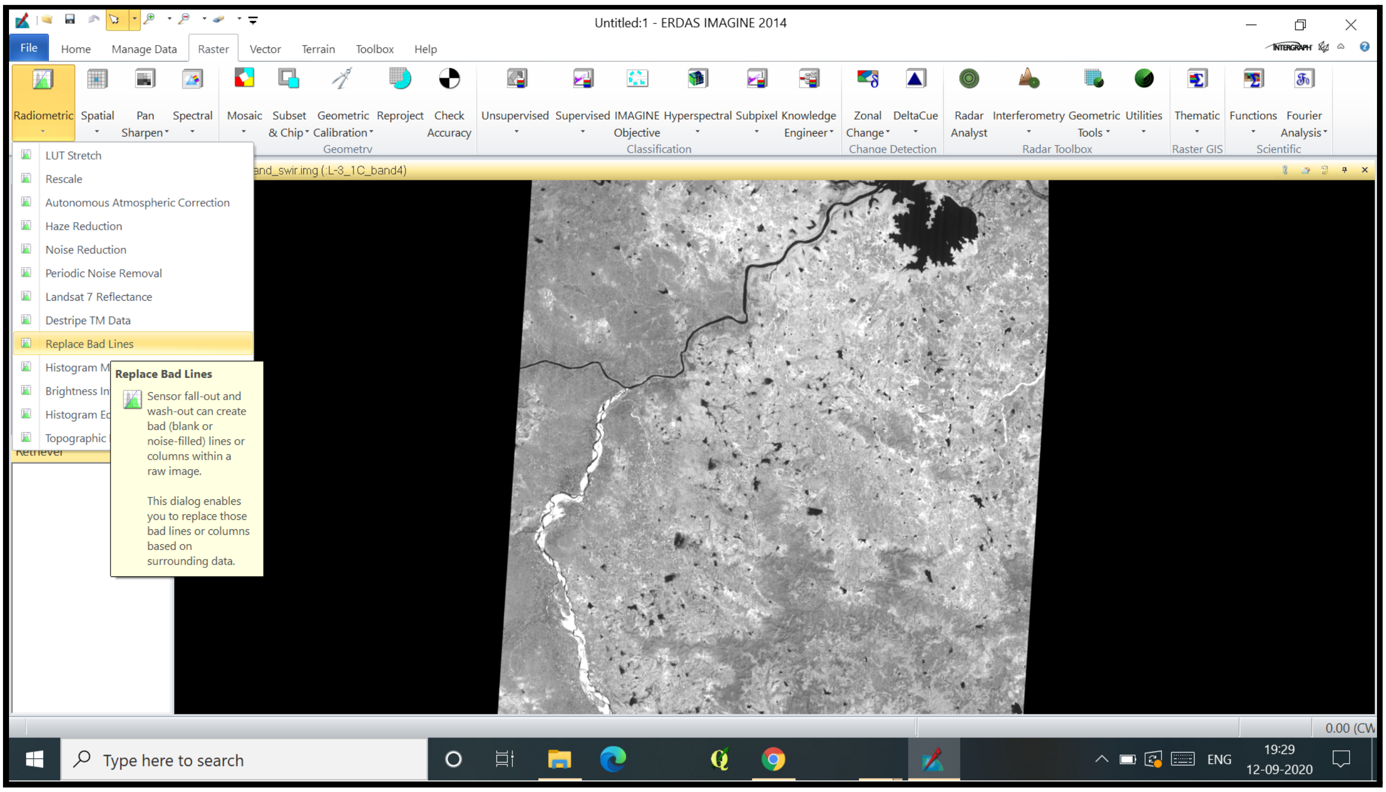


Replace Bad lines

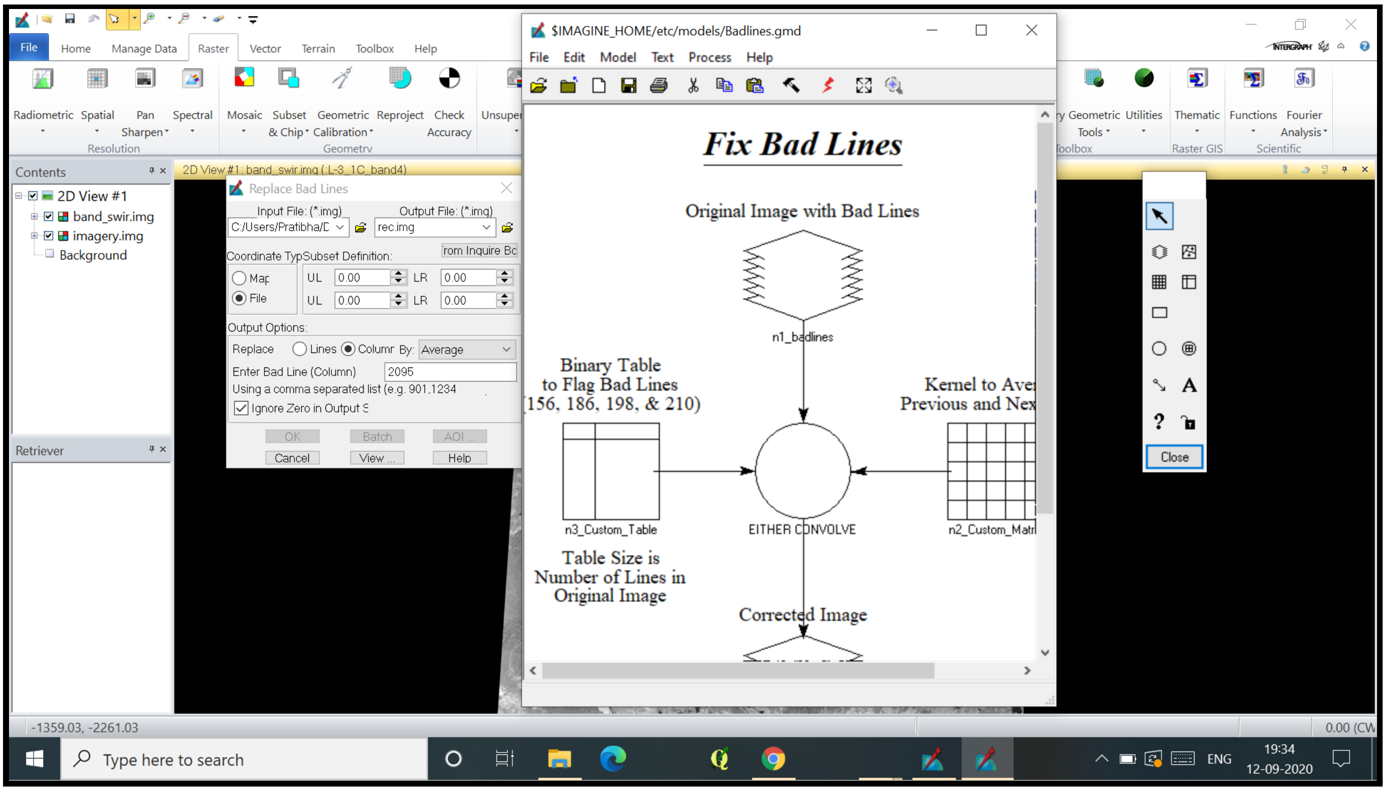
Prerequisite*:* Striping should be ***purely vertical***.

It is much more ***customizable*** and provides replacement in band or column no. Here, stripings are **not vertical,** therefore no further processing.

Step1- Go to **Raster > Radiometric > Replace Bad Lines**



Step 2- In the **Replace Badline tab**, import the file to be rectified, enable column, in By choose Average, Enter Badline No.(Column), enable Ignore 0 statistics. Give output file name and click ok.

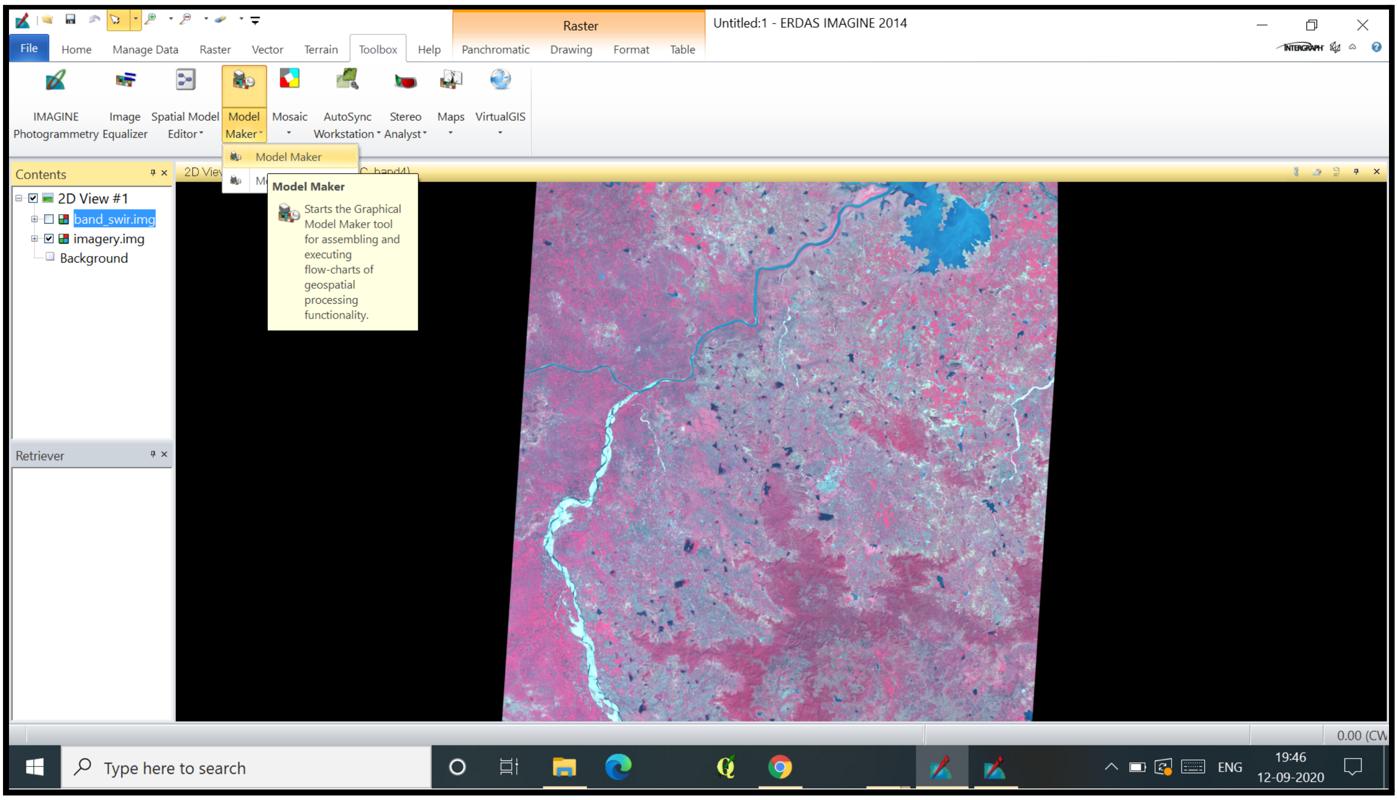


PART-II

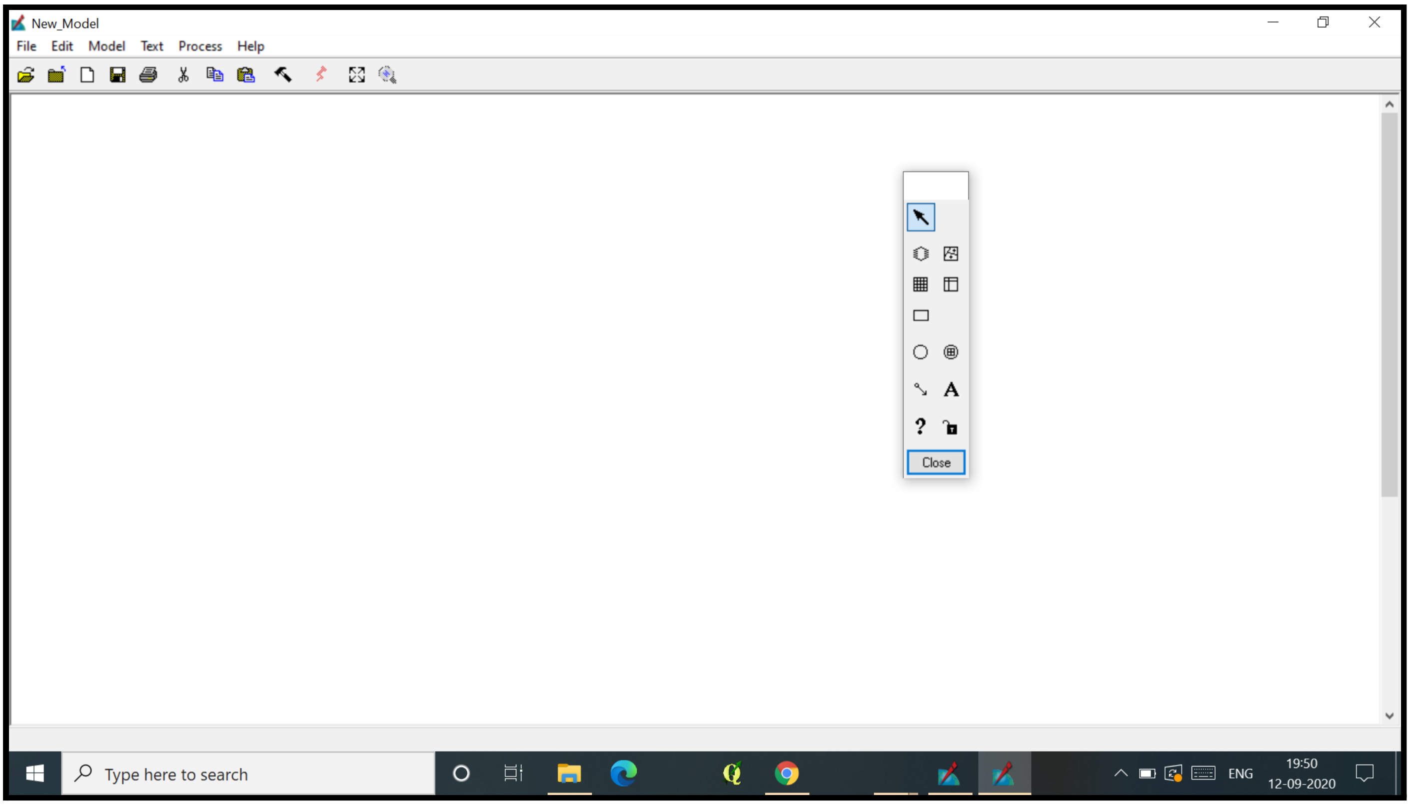
DARK OBJECT SUBTRACTION - Atmospheric Correction Tool

(Liss- no built-in module i.e. why use model maker tool)

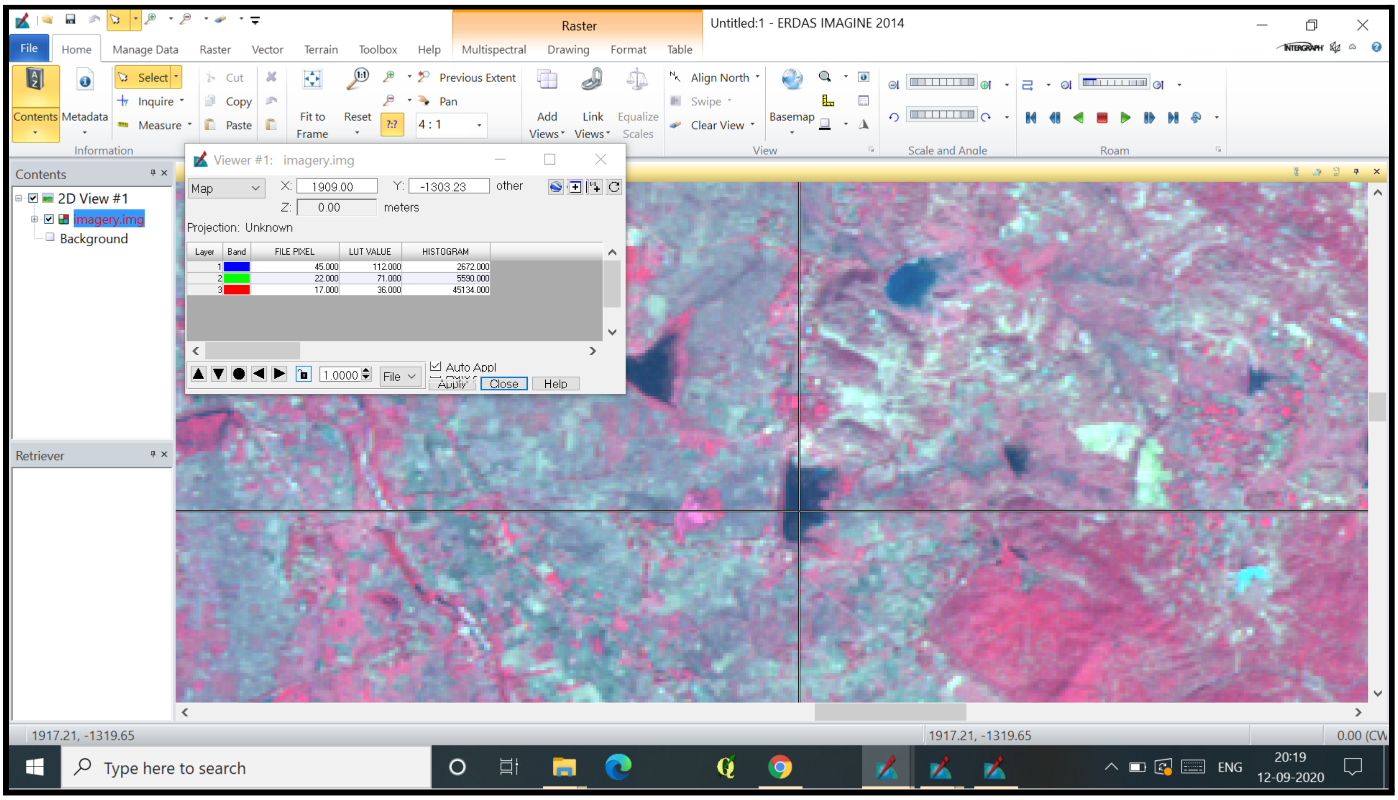
<u>Step 1</u>:To go **Toolbar > Model Maker > Model Maker**



New Model tab will appear. Create the model here.



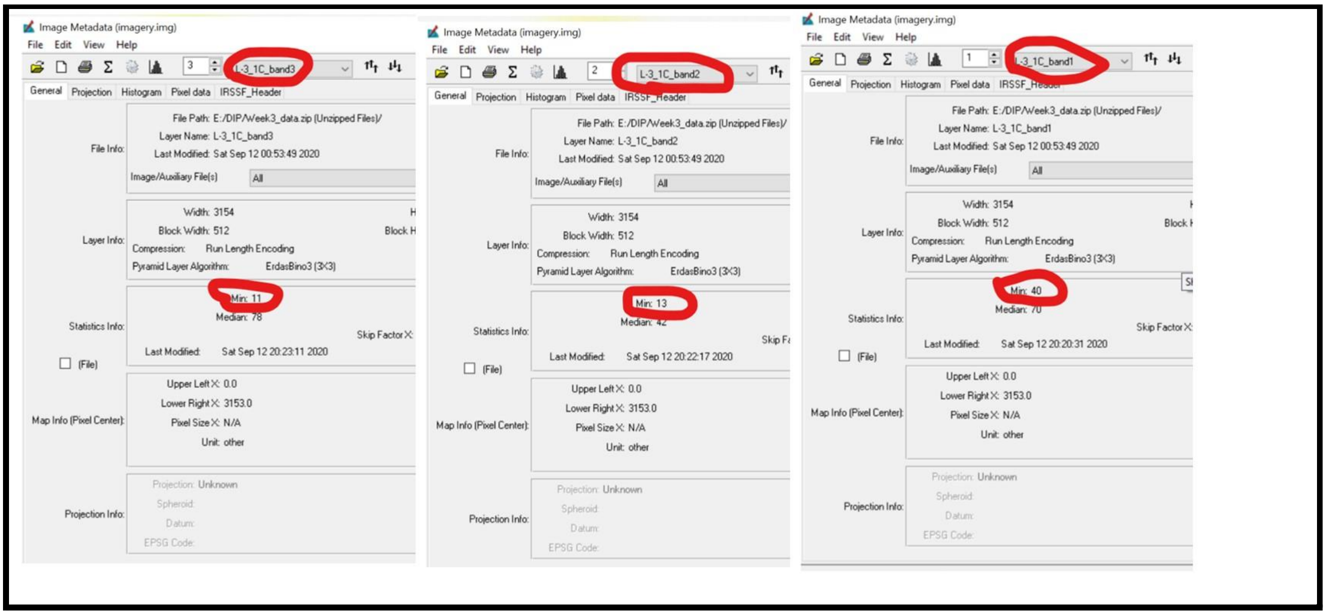
Step 2: **Hit and try method** to identify the offset value of each band using **inquire.**



Step3: To **Recalculate Statistics** and find the **offset values** for NIR, Red and Green band.

To go **Metadata > Commutate Pyramid Layer/ Statistics.**

Pyramid Layer/ Statistics Generation Option tab opens, enables ignore 0 and clicks on OK.

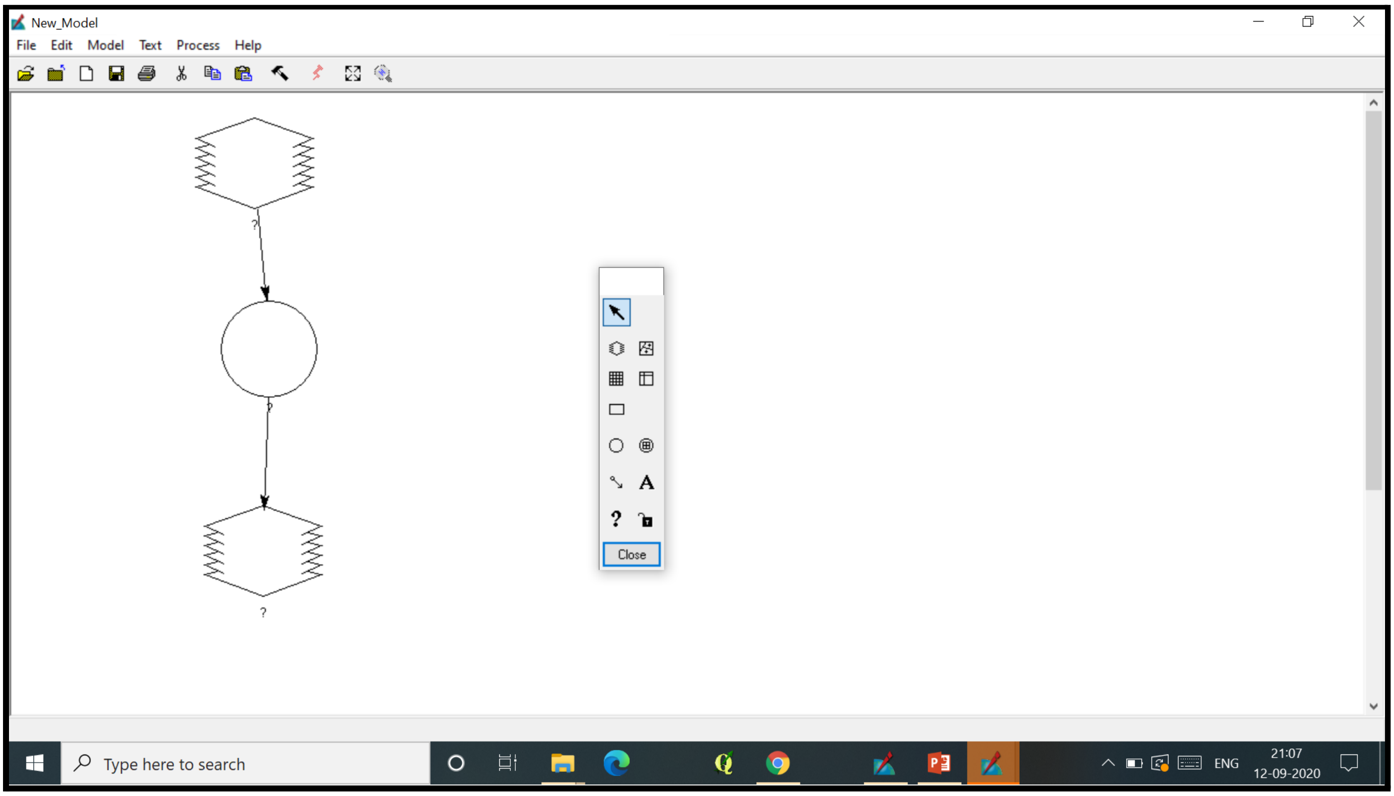


Offset Values- NIR min- 11 (Band 3)

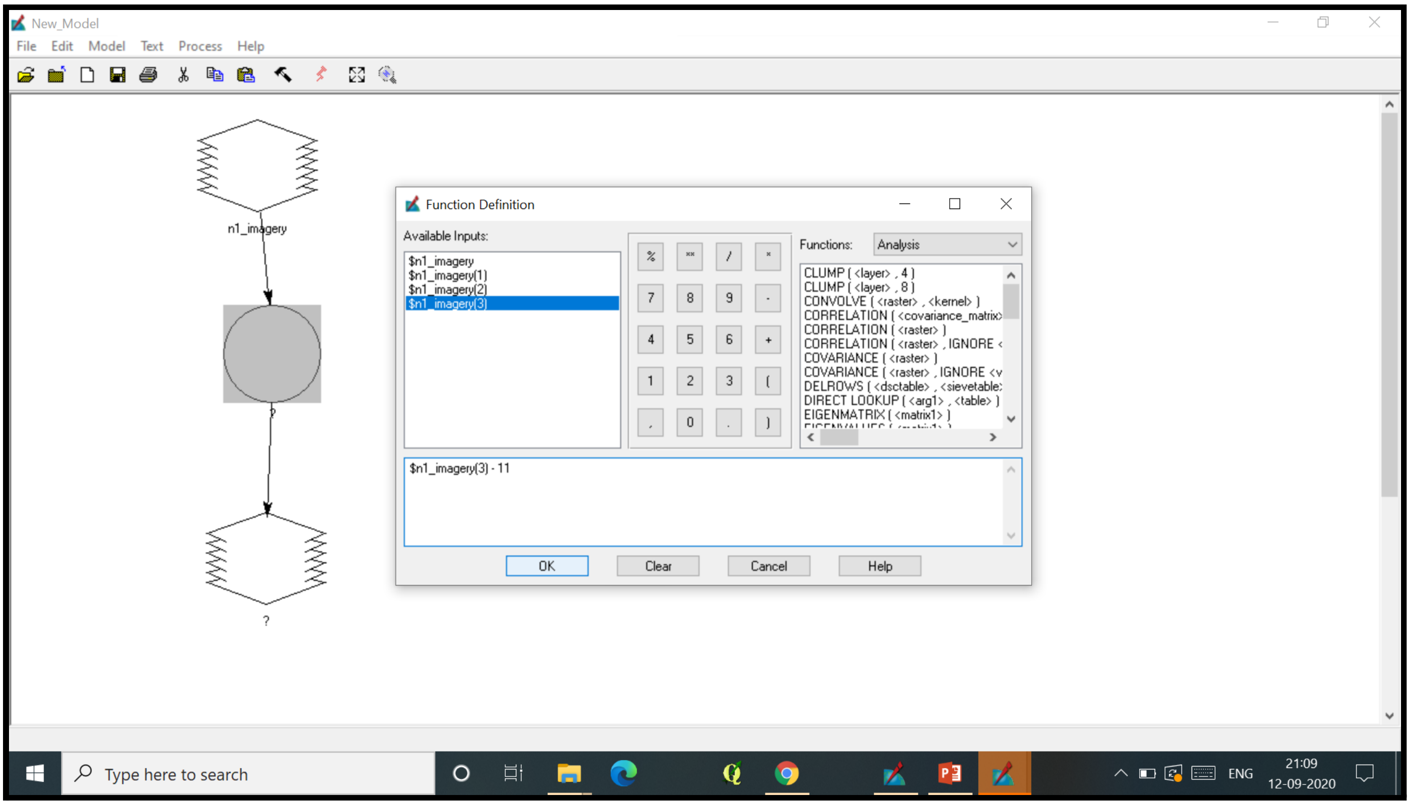
Red- 13 (Band 2)

Green- 40 (Band 1) ***Shorter wavelength, min value increases because more scattering i.e path radiance contribution/ atmospheric component is more. This is an estimation not absolute correction***

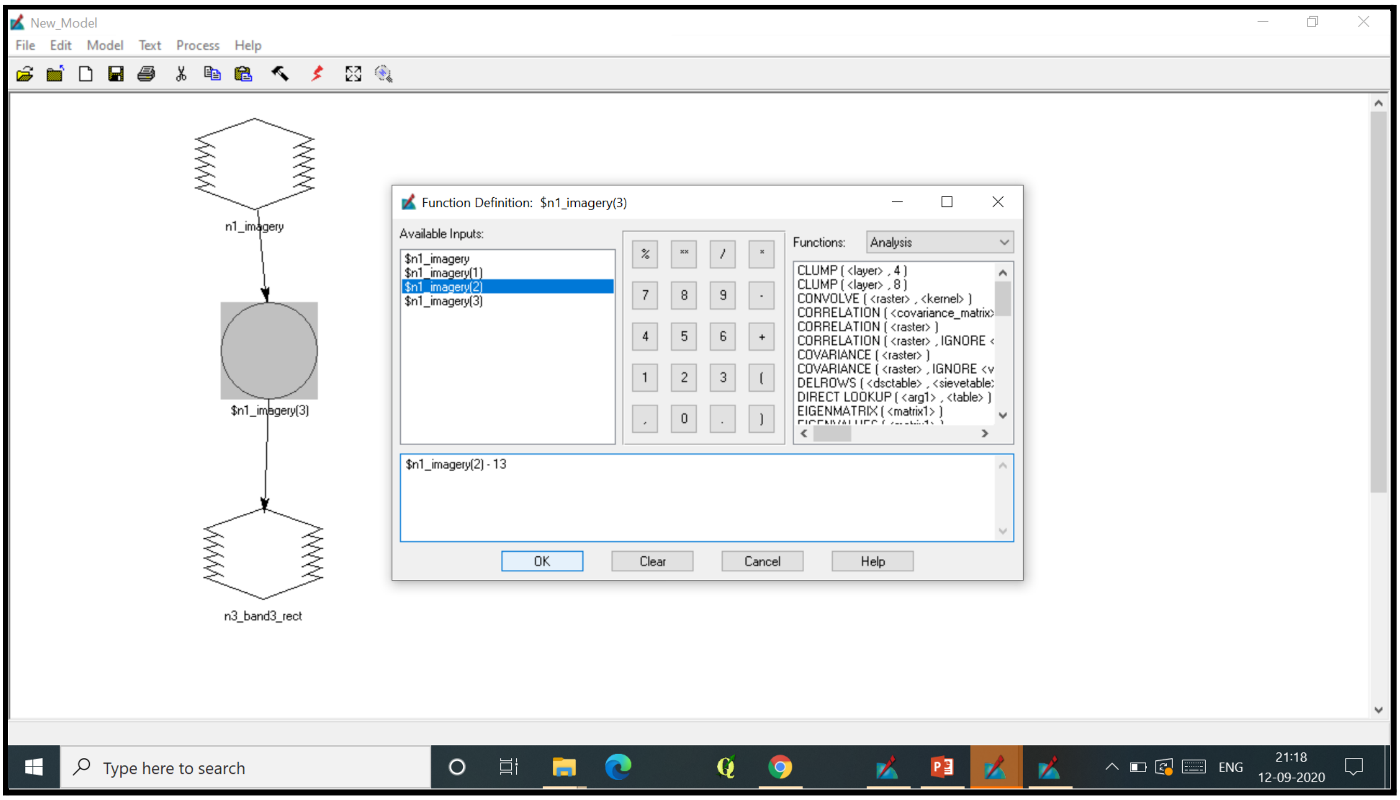
<u>Step 4:</u> After opening the new model tab, click and drop rasters, function and join them & **model is created.**



<u>Step 5:</u> Double click on the raster, tab appears, input the file and click ok. Then double click on the function, below imaginary 3 bands appears. Select one band and then select -(minus) function and write the offset value for that particular band and click ok. Then click on output raster and file output file name. Finally click on the **Execute Model icon.**

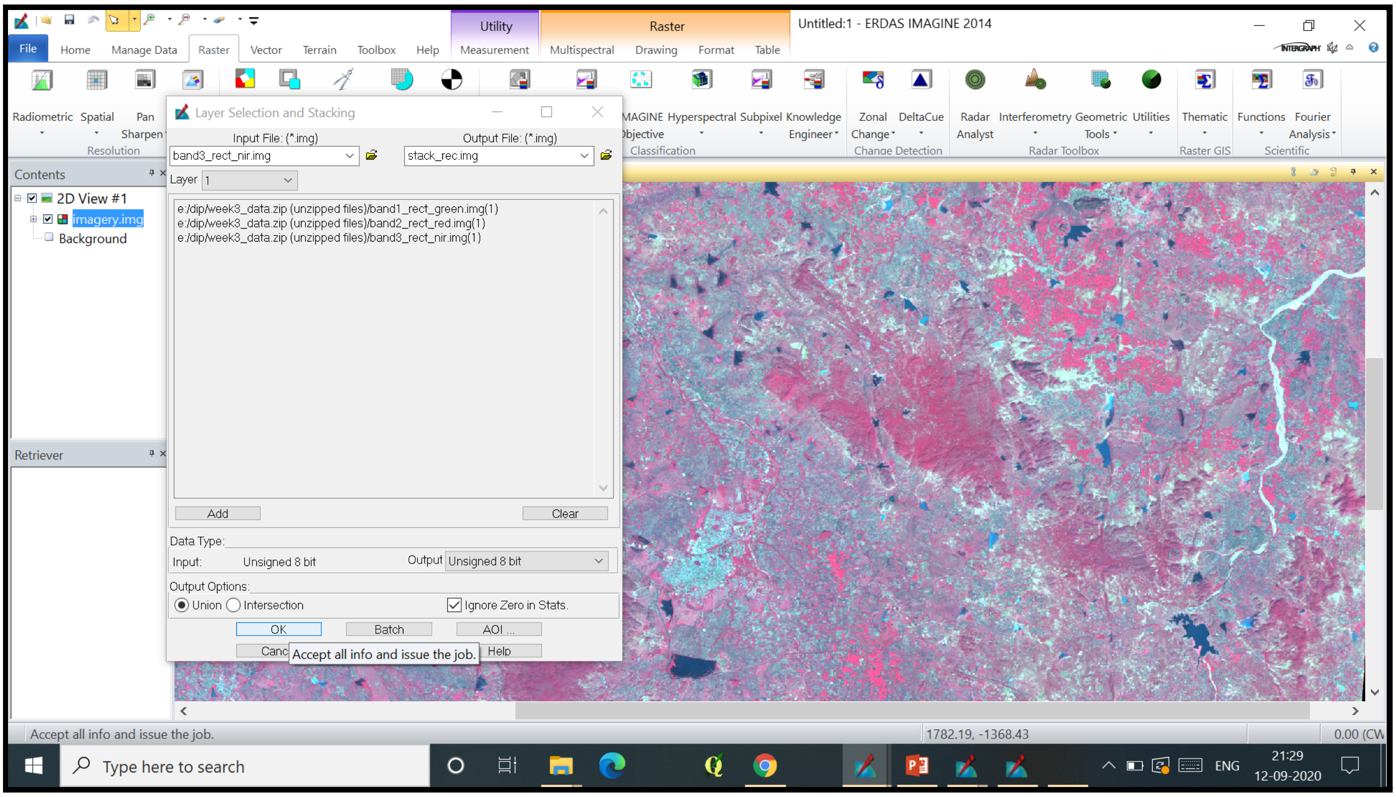


Step 6: Within the same model, change the function i.e select other 2 bands one by one and execute the model.

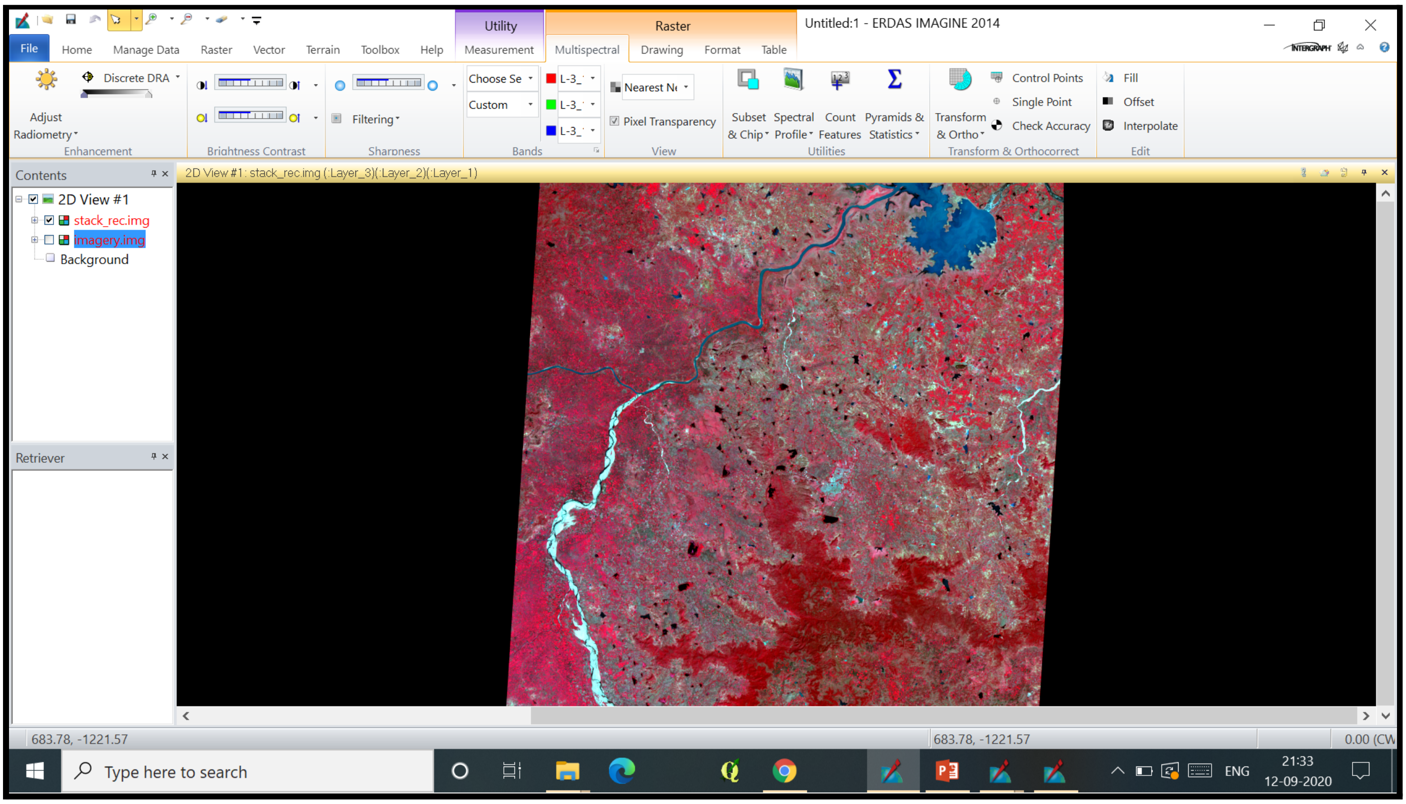


Step 7: **Stack the rectified layers sequentially.**

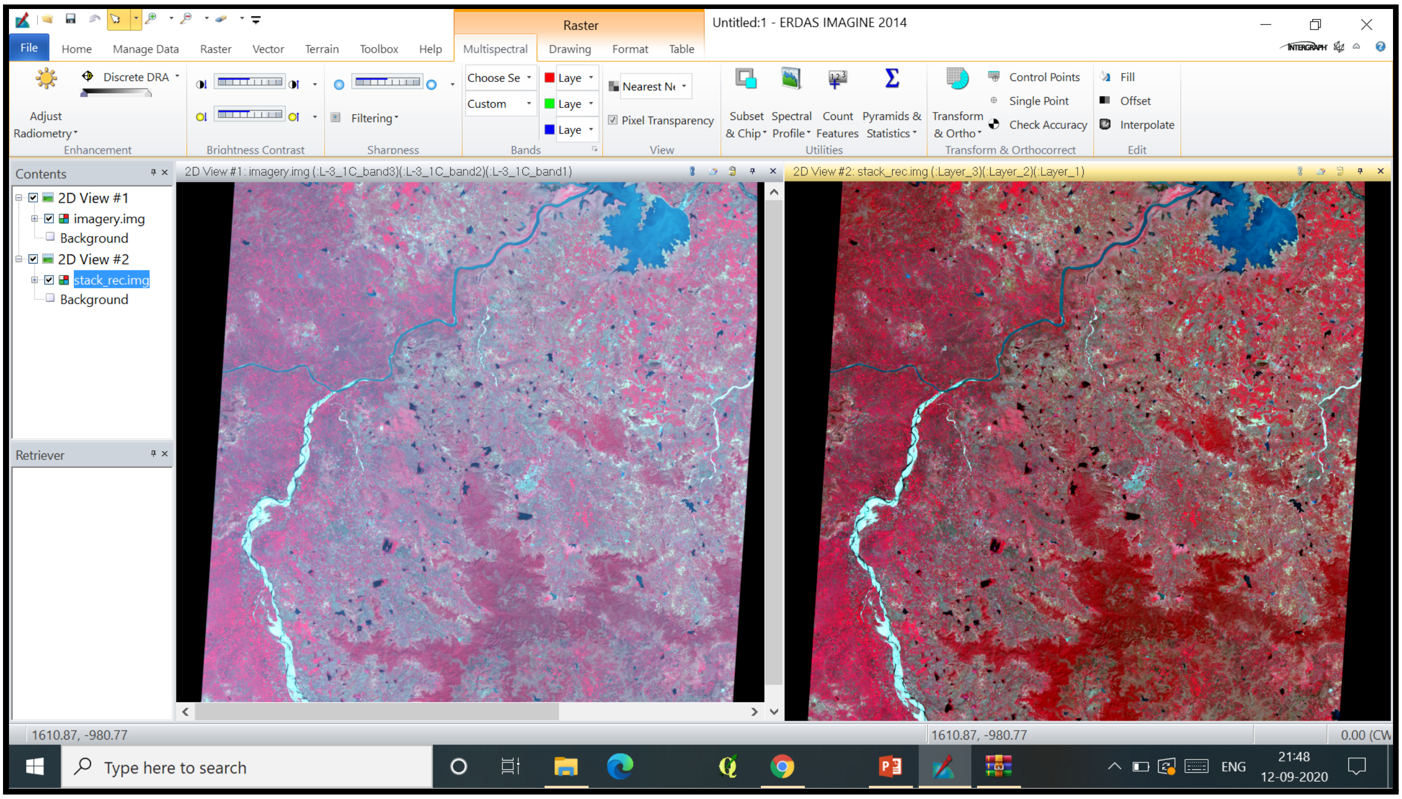
To go **Raster > Spectral > Stack Layers.** Input the band one by one sequentially, enable ignore 0 statistics and give output file name and click ok.



Step 8: Open the **stacked rectified image.**



Step 9: Open the raw image and stacked rectified image in Standard FCC using split view.



The rectified image is **enhanced all together**, has **better contrast** (also because of ignoring 0 statistics) , has **better display** and **haziness is also removed** and features can be better identified.

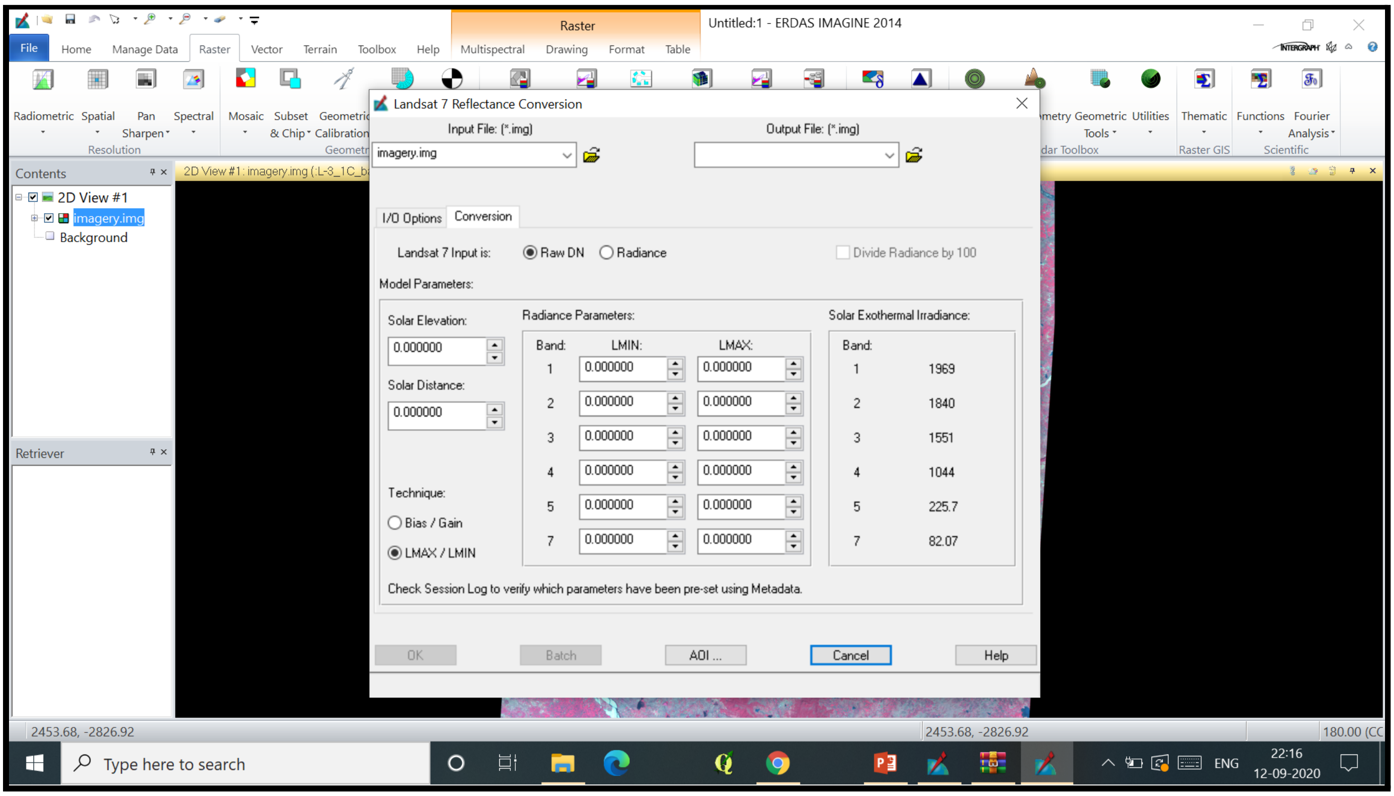
PART - III

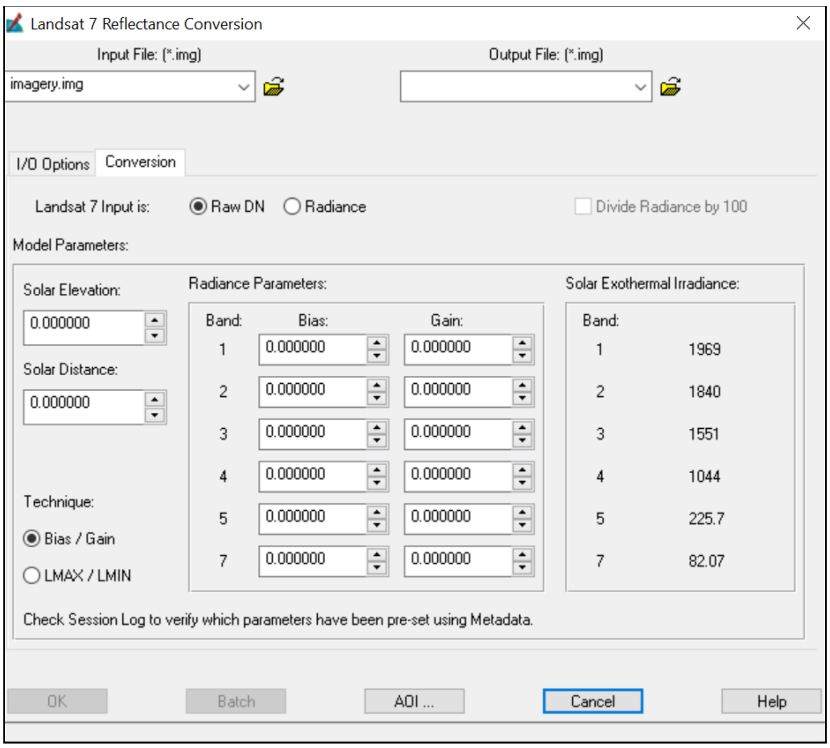
DN To TOA Reflectance Process in Erdas

Built in module for Landsat -7

<u>Step 1:</u> To go **Raster > Radiometric > Landsat 7 Reflectance**

Input the file and selection **Conversion.** In Technique, Select **LMAX/LMIN.**





Parameters required to convert the data and their sources

1. **DN to radiance**

This correction is done for one band at a time.

Using spectral radiance scaling method **(LMAX/ LMIN)** we need,

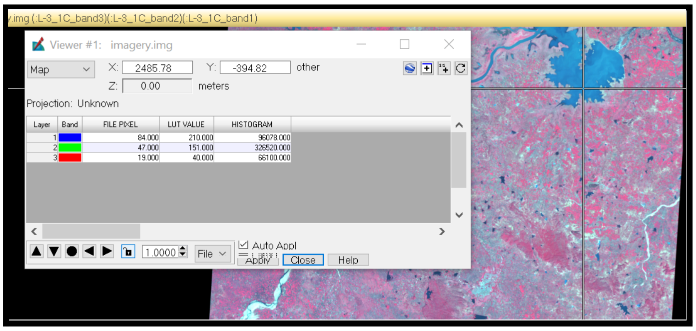
$$L_\lambda = ((LMAX_\lambda - LMIN_\lambda)/(QCALMAX - QCALMIN)) * (QCAL - QCALMIN) + LMIN_\lambda$$

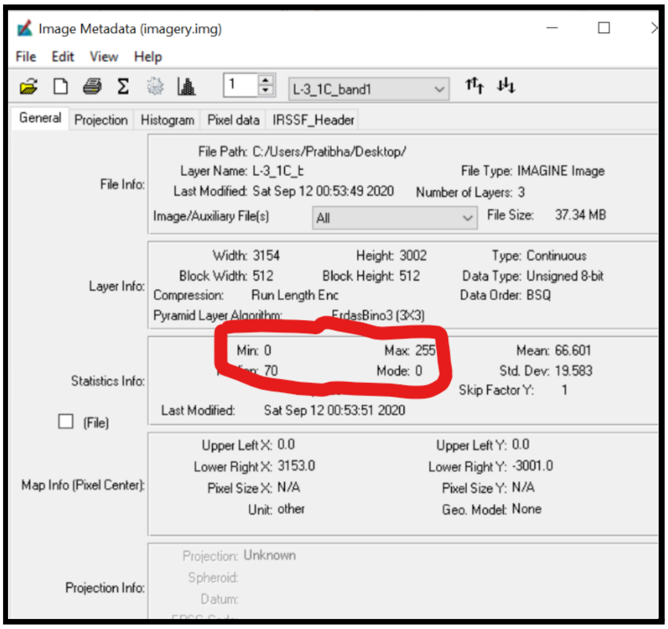
L_λ is the cell value as radiance (To find??)

QCAL = digital number (**From inquire: pixel value is QCAL for that particular band)**

$LMIN_\lambda$ = spectral radiance scales to QCALMIN = **0 (Metadata)**

$LMAX_\lambda$ = spectral radiance scales to QCALMAX = **255 (Metadata)**





2. Radiance to reflectance

$$\rho_\lambda = \pi * L_\lambda * d^2 / ESUN_\lambda * \cos\theta_s$$

ρ_λ = Reflectance

L_λ= spectral radiance **(from earlier step)**

d = Earth-Sun distance in astronomical units **(Meta data)**

$ESUN_\lambda$ = mean solar exoatmospheric irradiances (**Given or website of agency)**

θ_s = solar zenith angle **(Meta data)**

In Erdas Imagine, Technique : **LMAX/LMIN** is used. Therefore, we need

a. Solar Elevation & Solar Distance

```
ROLL_ANGLE = -0.001
SUN_AZIMUTH = 143.51717922
SUN_ELEVATION = 43.90079620
EARTH_SUN_DISTANCE = 0.9892977
SATURATION_BAND_1 = "N"
SATURATION_BAND_2 = "Y"
SATURATION_BAND_3 = "N"
SATURATION_BAND_4 = "N"
SATURATION_BAND_5 = "N"
SATURATION_BAND_6 = "Y"
SATURATION_BAND_7 = "Y"
SATURATION_BAND_8 = "N"
SATURATION_BAND_9 = "N"
```

Solar Elevation (ɑ) and Earth sun distance (Solar distance)from metadata

yceo.yale.edu/how-convert-landsat-dns-top-atmosphere-toa-reflectance

Table 11.4 Earth-Sun Distance in Astronomical Units

JULIAN DAY	DISTANCE	JULIAN DAY	DISTANCE	JULIAN DAY	DISTANCE	JULIAN DAY	DISTANCE	JULIAN DAY	DISTANCE
1	.9832	74	.9945	152	1.0140	227	1.0128	305	.9925
15	.9836	91	.9993	166	1.0158	242	1.0092	319	.9892
32	.9853	106	1.0033	182	1.0167	258	1.0057	335	.9860
46	.9878	121	1.0076	196	1.0165	274	1.0011	349	.9843
60	.9909	135	1.0109	213	1.0149	288	.9972	365	.9833

Earth-sun distance in astronomical units. (agency website or metadata)

b. **LMIN$_\lambda$** = spectral radiance scales to QCALMIN = 0 (Metadata) **(From earlier step)**

c. **LMAX$_\lambda$** = spectral radiance scales to QCALMAX = 255 (Metadata)

```
RADIANCE_MAXIMUM_BAND_1 = 776.59644
RADIANCE_MINIMUM_BAND_1 = -64.13158
RADIANCE_MAXIMUM_BAND_2 = 795.24420
RADIANCE_MINIMUM_BAND_2 = -65.67152
RADIANCE_MAXIMUM_BAND_3 = 732.81073
RADIANCE_MINIMUM_BAND_3 = -60.51575
RADIANCE_MAXIMUM_BAND_4 = 617.94733
RADIANCE_MINIMUM_BAND_4 = -51.03029
RADIANCE_MAXIMUM_BAND_5 = 378.15292
RADIANCE_MINIMUM_BAND_5 = -31.22799
RADIANCE_MAXIMUM_BAND_6 = 94.04320
RADIANCE_MINIMUM_BAND_6 = -7.76612
RADIANCE_MAXIMUM_BAND_7 = 31.69759
RADIANCE_MINIMUM_BAND_7 = -2.61760
RADIANCE_MAXIMUM_BAND_8 = 699.34625
RADIANCE_MINIMUM_BAND_8 = -57.75224
RADIANCE_MAXIMUM_BAND_9 = 147.79074
RADIANCE_MINIMUM_BAND_9 = -12.20461
RADIANCE_MAXIMUM_BAND_10 = 22.00180
RADIANCE_MINIMUM_BAND_10 = 0.10033
RADIANCE_MAXIMUM_BAND_11 = 22.00180
RADIANCE_MINIMUM_BAND_11 = 0.10033
```

<u>LMAX and LMIN for all the bands given separately in metadata.</u>

d. Solar Exothermal Irradiance (ESUN$_\lambda$)

New assignment: "Week02 | Week02_Practical: Radiome | How to convert Landsat DN | Pratibha Patel - Week02

yceo.yale.edu/how-convert-landsat-dns-top-atmosphere-toa-reflectance

Table 11.3 ETM+ Solar Spectral Irradiances

BAND	WATTS/(METER SQUARED * MM)
1	1969.000
2	1840.000
3	1551.000
4	1044.000
5	225.700
7	82.07
8	1368.000

Type here to search

Solar Exothermal Irradiance:

Band:	
1	1969
2	1840
3	1551
4	1044
5	225.7
7	82.07

Solar Exothermal Irradiance (ESUN$_\lambda$**)** value provided for all bands after calibration in **ETM+ and Landsat 7 respectively.** Can be accessed from the reflectance conversion box or can be accessed from the website of the satellite supply agency.

Similarly, **Reflectance min & reflectance max and QCALmin and QCAL max** is also provided for each band separately inmeta data.

```
LC08_L1TP_146040_20190223_20190308_01_T1_MTL - Notepad
File  Edit  Format  View  Help
  GROUP = MIN_MAX_REFLECTANCE
    REFLECTANCE_MAXIMUM_BAND_1 = 1.210700
    REFLECTANCE_MINIMUM_BAND_1 = -0.099980
    REFLECTANCE_MAXIMUM_BAND_2 = 1.210700
    REFLECTANCE_MINIMUM_BAND_2 = -0.099980
    REFLECTANCE_MAXIMUM_BAND_3 = 1.210700
    REFLECTANCE_MINIMUM_BAND_3 = -0.099980
    REFLECTANCE_MAXIMUM_BAND_4 = 1.210700
    REFLECTANCE_MINIMUM_BAND_4 = -0.099980
    REFLECTANCE_MAXIMUM_BAND_5 = 1.210700
    REFLECTANCE_MINIMUM_BAND_5 = -0.099980
    REFLECTANCE_MAXIMUM_BAND_6 = 1.210700
    REFLECTANCE_MINIMUM_BAND_6 = -0.099980
    REFLECTANCE_MAXIMUM_BAND_7 = 1.210700
    REFLECTANCE_MINIMUM_BAND_7 = -0.099980
    REFLECTANCE_MAXIMUM_BAND_8 = 1.210700
    REFLECTANCE_MINIMUM_BAND_8 = -0.099980
    REFLECTANCE_MAXIMUM_BAND_9 = 1.210700
    REFLECTANCE_MINIMUM_BAND_9 = -0.099980
  END_GROUP = MIN_MAX_REFLECTANCE
  GROUP = MIN_MAX_PIXEL_VALUE
    QUANTIZE_CAL_MAX_BAND_1 = 65535
    QUANTIZE_CAL_MIN_BAND_1 = 1
    QUANTIZE_CAL_MAX_BAND_2 = 65535
    QUANTIZE_CAL_MIN_BAND_2 = 1
    QUANTIZE_CAL_MAX_BAND_3 = 65535
    QUANTIZE_CAL_MIN_BAND_3 = 1
    QUANTIZE_CAL_MAX_BAND_4 = 65535
    QUANTIZE_CAL_MIN_BAND_4 = 1
    QUANTIZE_CAL_MAX_BAND_5 = 65535
    QUANTIZE_CAL_MIN_BAND_5 = 1
    QUANTIZE_CAL_MAX_BAND_6 = 65535
    QUANTIZE_CAL_MIN_BAND_6 = 1
    QUANTIZE_CAL_MAX_BAND_7 = 65535
```