

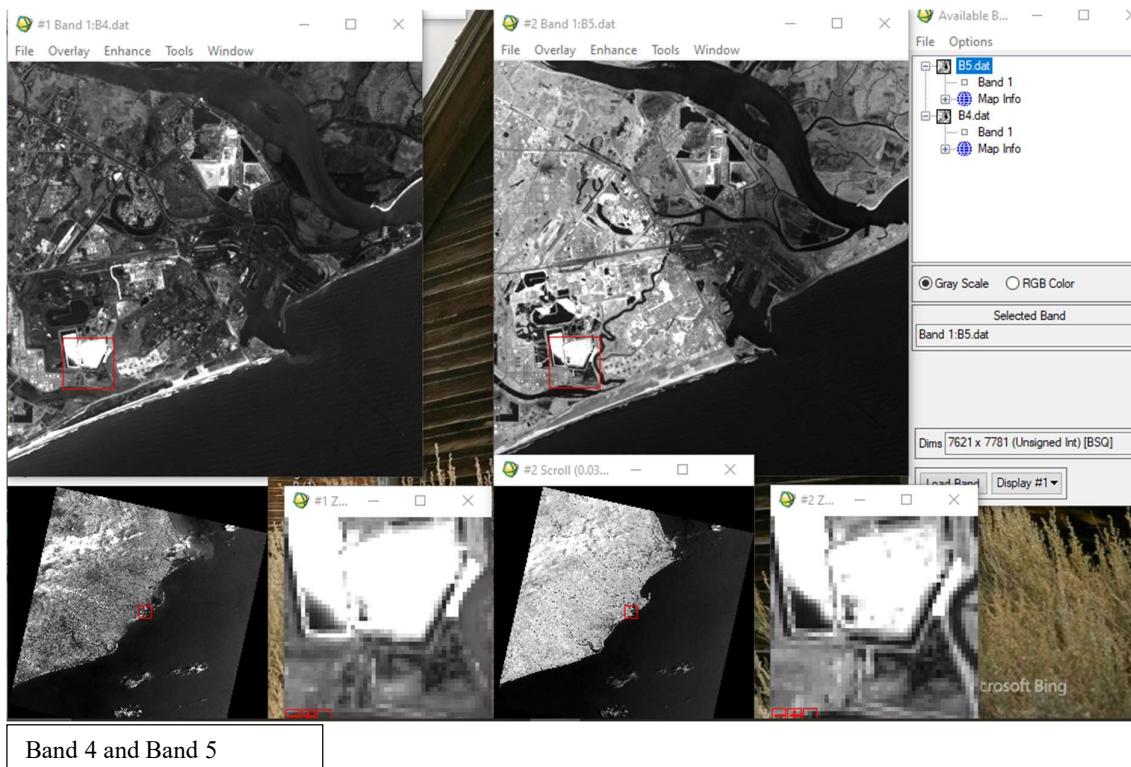
LAB 9 ASSIGNMENT
CE 593 ADVANCED REMOTE SENSING

1. NDVI calculation

NDVI measures vegetation health, density, and productivity by analysing reflectance in Near-Infrared (NIR) and Red (R) spectral bands

$$\text{NDVI} = (\text{NIR} - \text{R}) / (\text{NIR} + \text{R})$$

- NIR = Near-Infrared band reflectance (e.g., Landsat 8 Band 5)
- R = Red band reflectance (e.g., Landsat 8 Band 4)



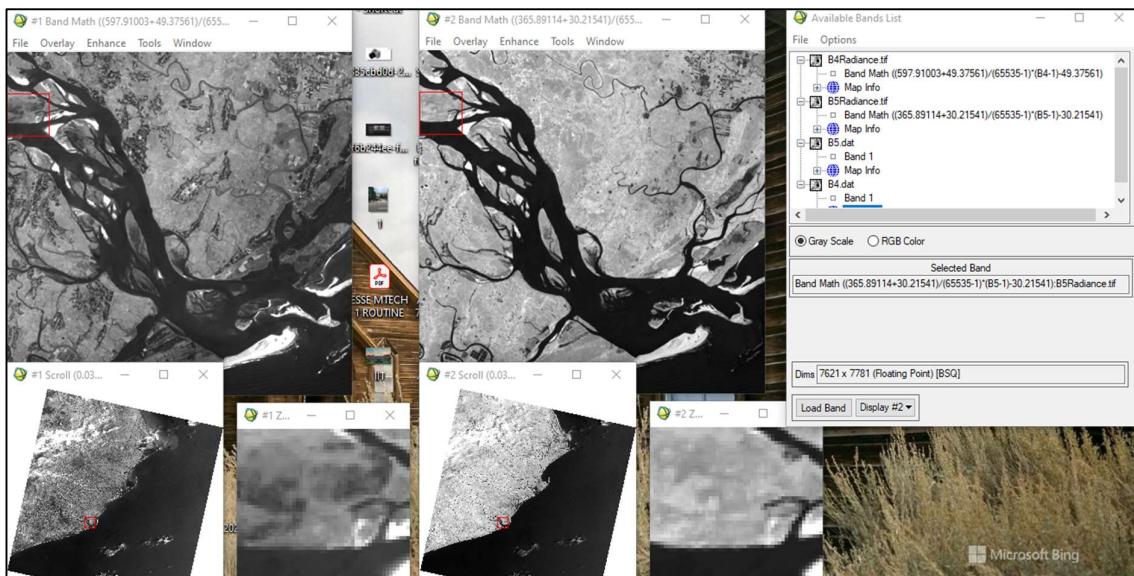
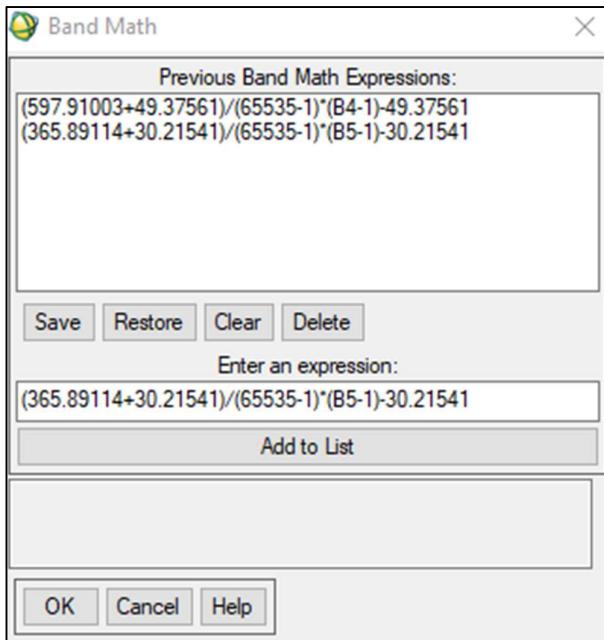
```
RADIANCE_MAXIMUM_BAND_4 = 597.91003
RADIANCE_MINIMUM_BAND_4 = -49.37561
RADIANCE_MAXIMUM_BAND_5 = 365.89114
RADIANCE_MINIMUM_BAND_5 = -30.21541
```

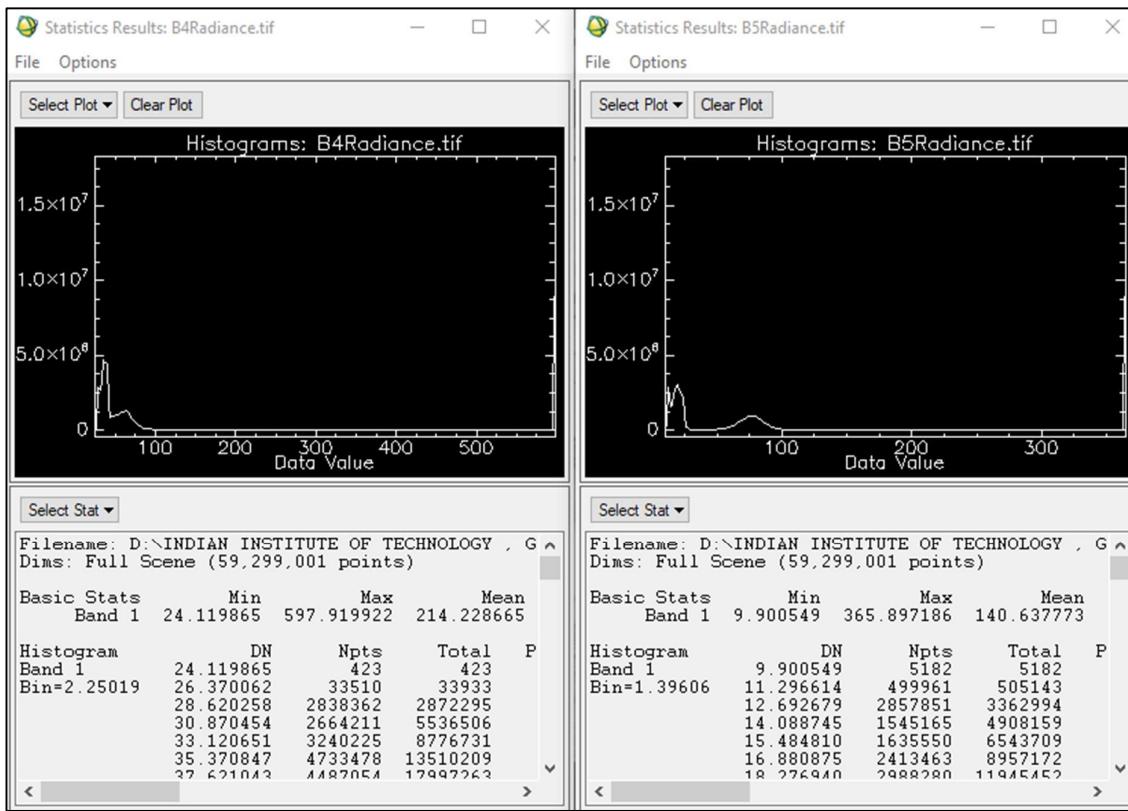
DN to Radiance Conversion

$$L = ((L_{max} - L_{min}) / (Q_{cal_{max}} - Q_{cal_{min}})) * (Q_{cal} - Q_{cal_{min}}) + L_{min}$$

$$(597.91003 + 49.37561) / (65535 - 1) * (B4 - 1) - 49.37561$$

$$(365.89114 + 30.21541) / (65535 - 1) * (B5 - 1) - 30.21541$$





Ref to rad:

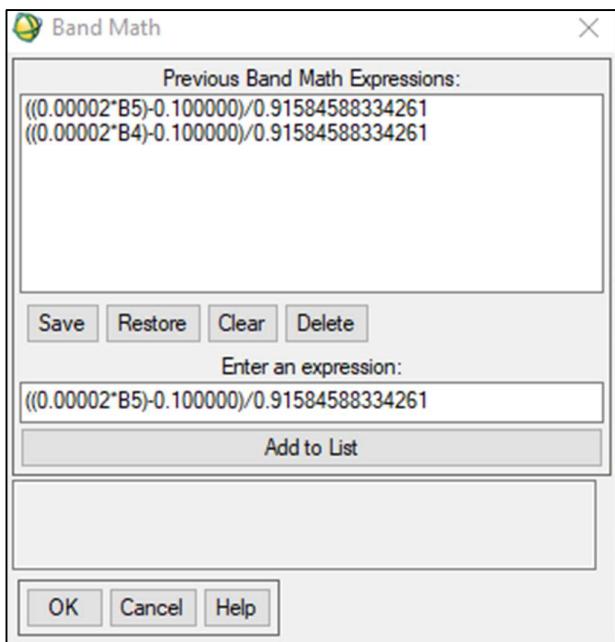
$$\text{Reflectance} = ((M\rho * Q_{\text{cal}}) + A\rho) / \sin(\Theta_{\text{SE}})$$

SUN_ELEVATION = 66.32614072

```

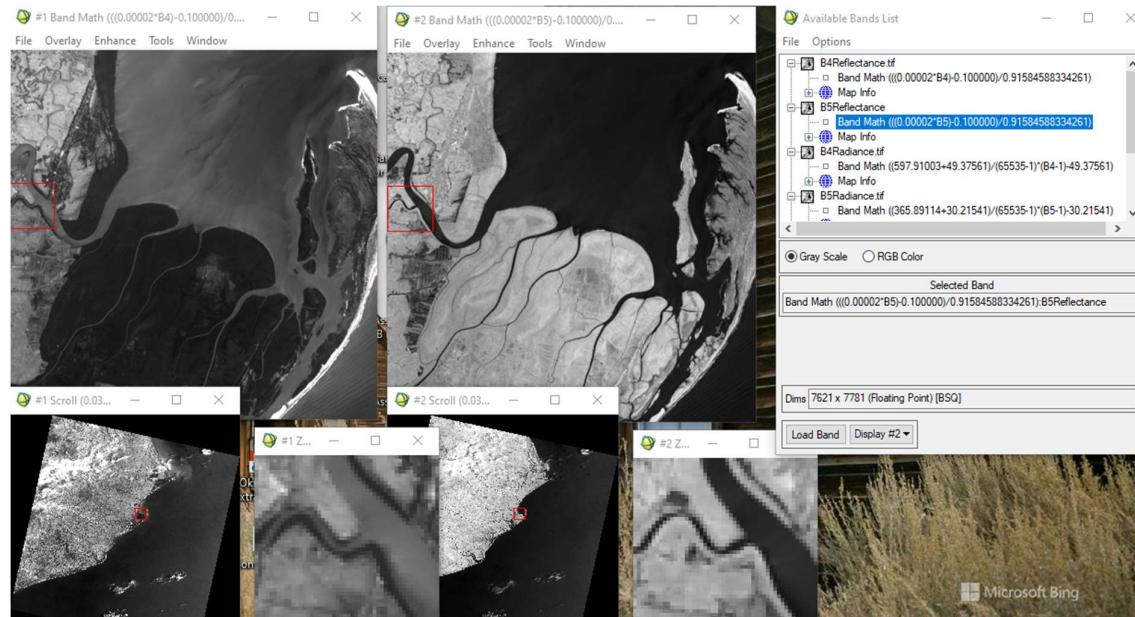
REFLECTANCE_MULT_BAND_1 = 2.0000E-05
REFLECTANCE_MULT_BAND_2 = 2.0000E-05
REFLECTANCE_MULT_BAND_3 = 2.0000E-05
REFLECTANCE_MULT_BAND_4 = 2.0000E-05
REFLECTANCE_MULT_BAND_5 = 2.0000E-05
REFLECTANCE_MULT_BAND_6 = 2.0000E-05
REFLECTANCE_MULT_BAND_7 = 2.0000E-05
REFLECTANCE_MULT_BAND_8 = 2.0000E-05
REFLECTANCE_MULT_BAND_9 = 2.0000E-05
REFLECTANCE_ADD_BAND_1 = -0.100000
REFLECTANCE_ADD_BAND_2 = -0.100000
REFLECTANCE_ADD_BAND_3 = -0.100000
REFLECTANCE_ADD_BAND_4 = -0.100000
REFLECTANCE_ADD_BAND_5 = -0.100000
REFLECTANCE_ADD_BAND_6 = -0.100000
REFLECTANCE_ADD_BAND_7 = -0.100000
REFLECTANCE_ADD_BAND_8 = -0.100000
REFLECTANCE_ADD_BAND_9 = -0.100000

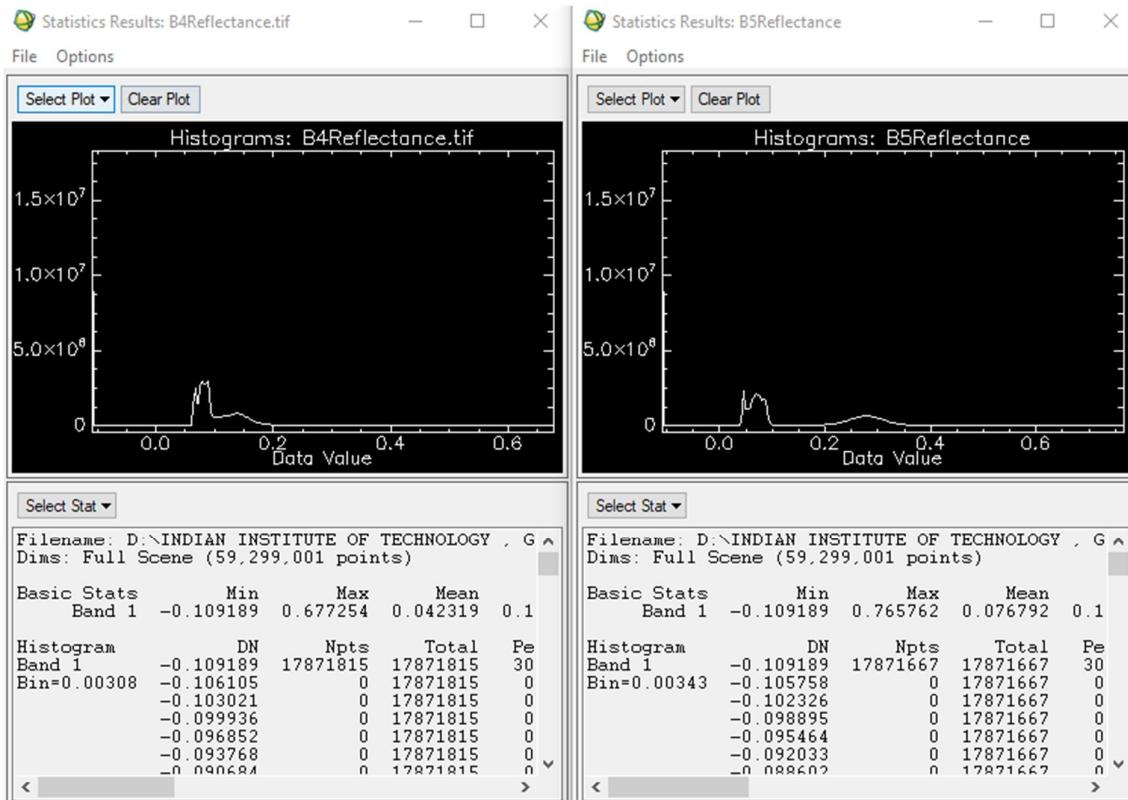
```



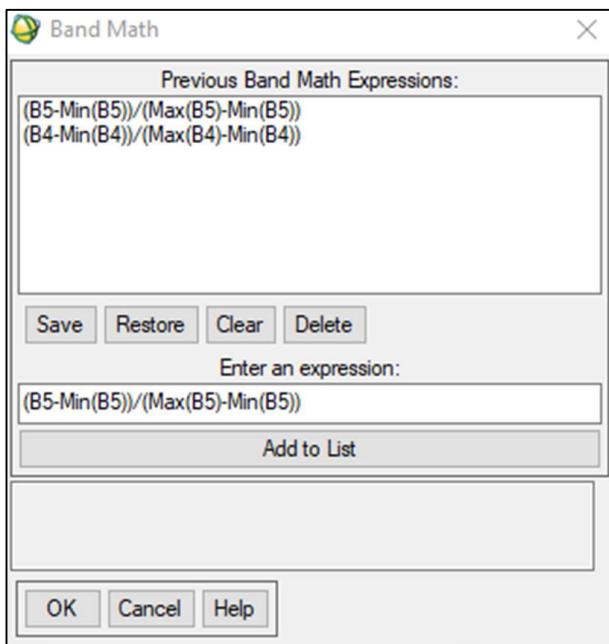
$((0.00002*B5)-0.100000)/0.91584588334261$

$((0.00002*B4)-0.100000)/0.91584588334261$



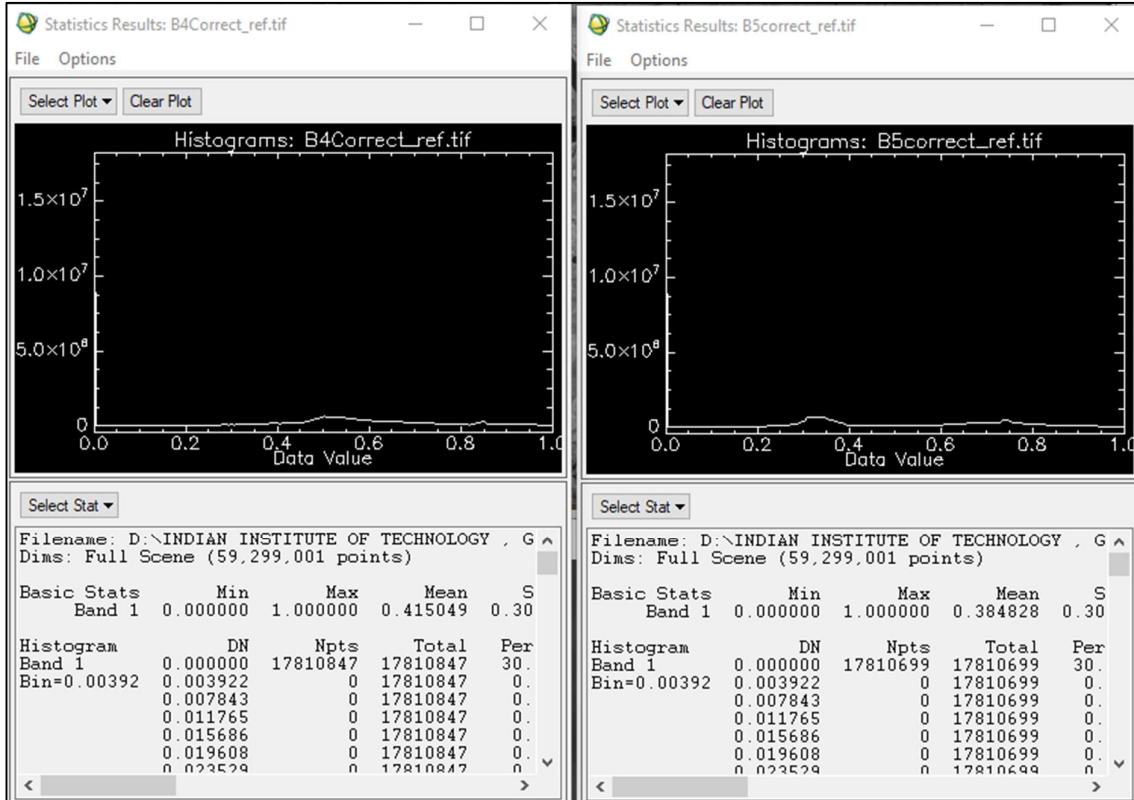
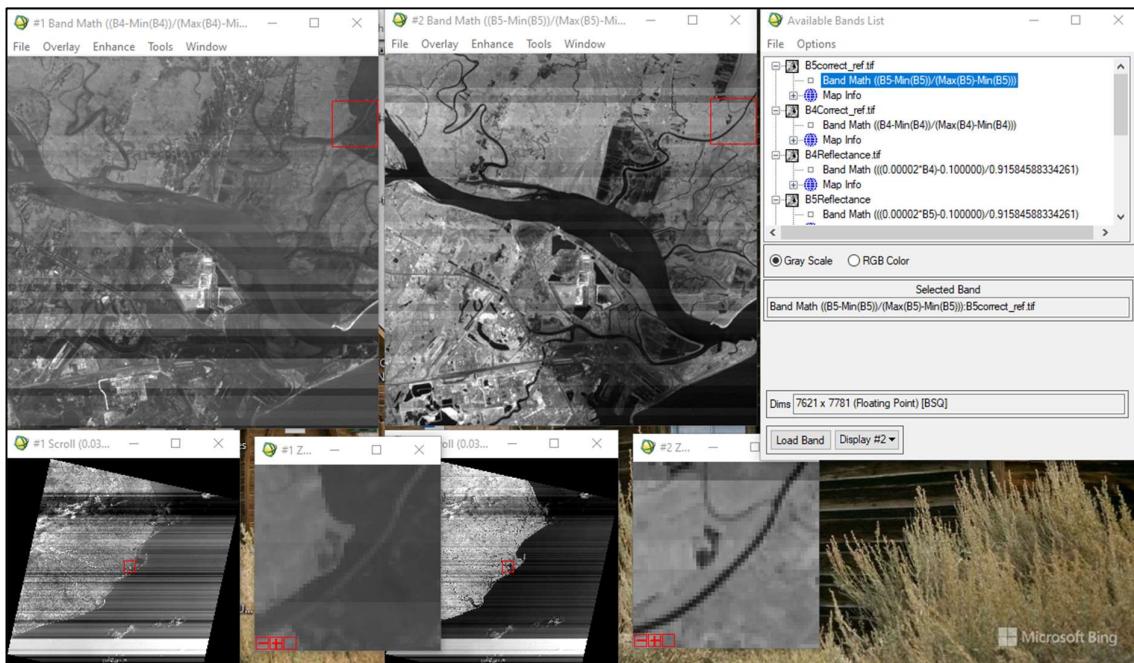


Normalised reflectance:

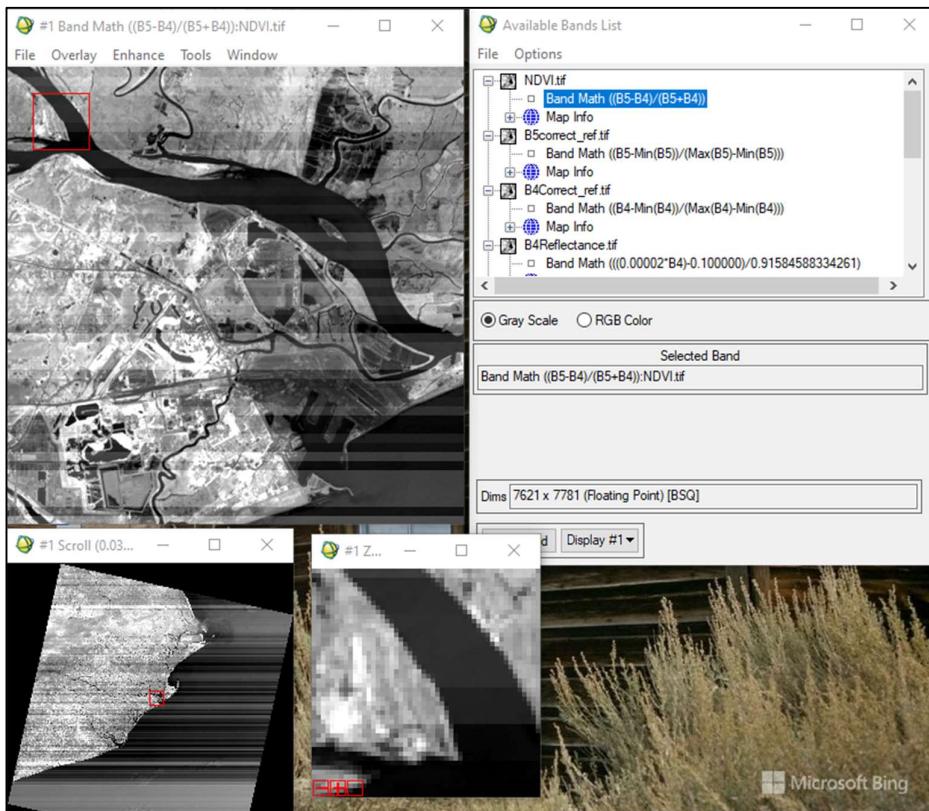
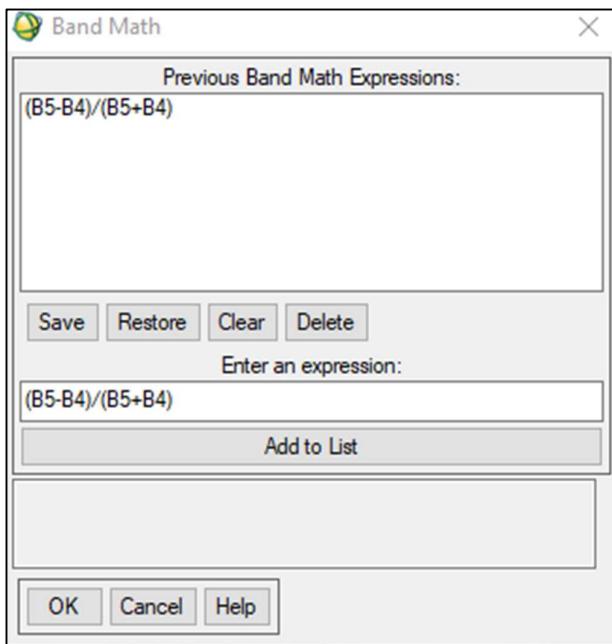


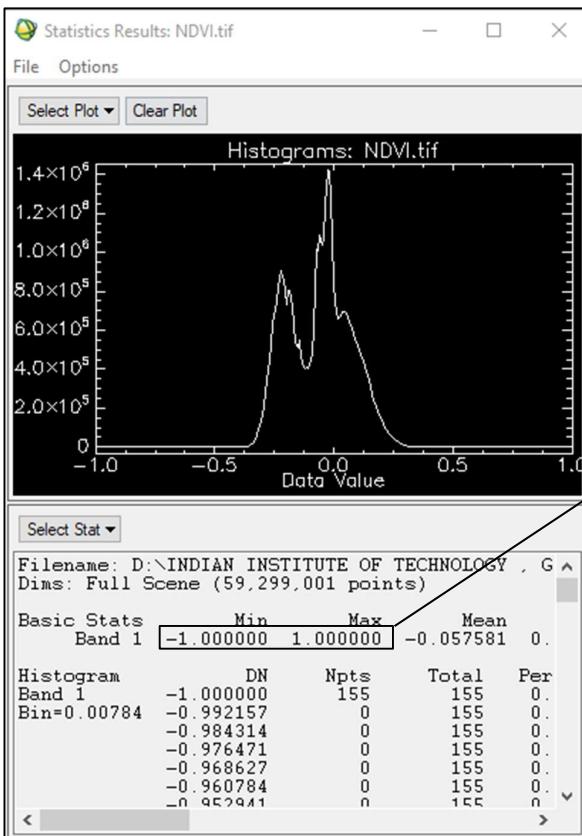
$(B4-\text{Min}(B4))/(\text{Max}(B4)-\text{Min}(B4))$

$(B5-\text{Min}(B5))/(\text{Max}(B5)-\text{Min}(B5))$



NDVI band math

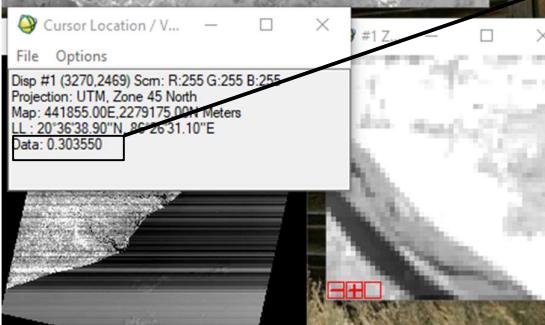


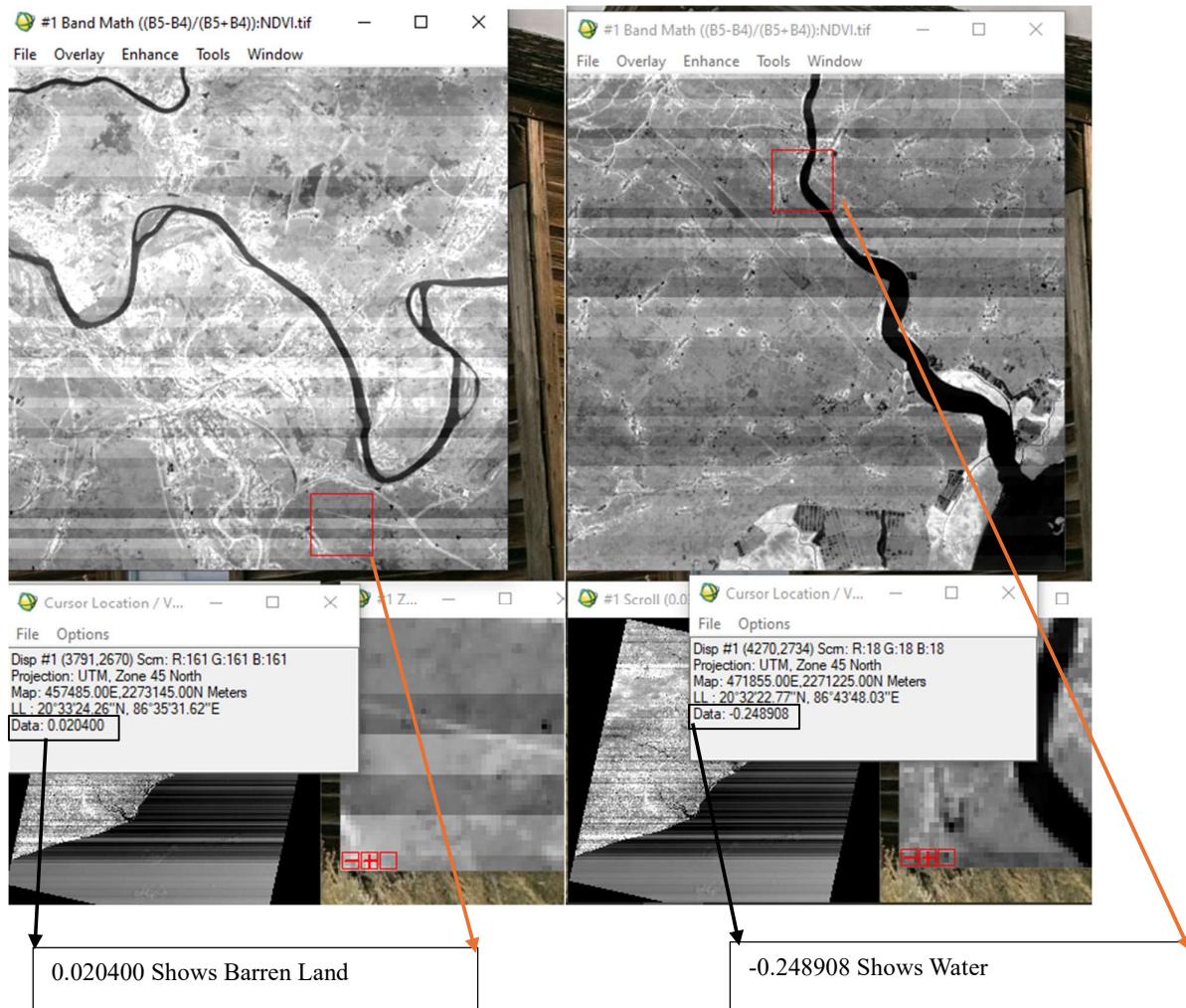


NDVI (Normalized Difference Vegetation Index)
values range from [-1 to 1.]
Healthy Vegetation / Forest – 0.6
Agriculture - [0.2-0.4]
Barren Land – [0-0.2]
Water/Glacier <0



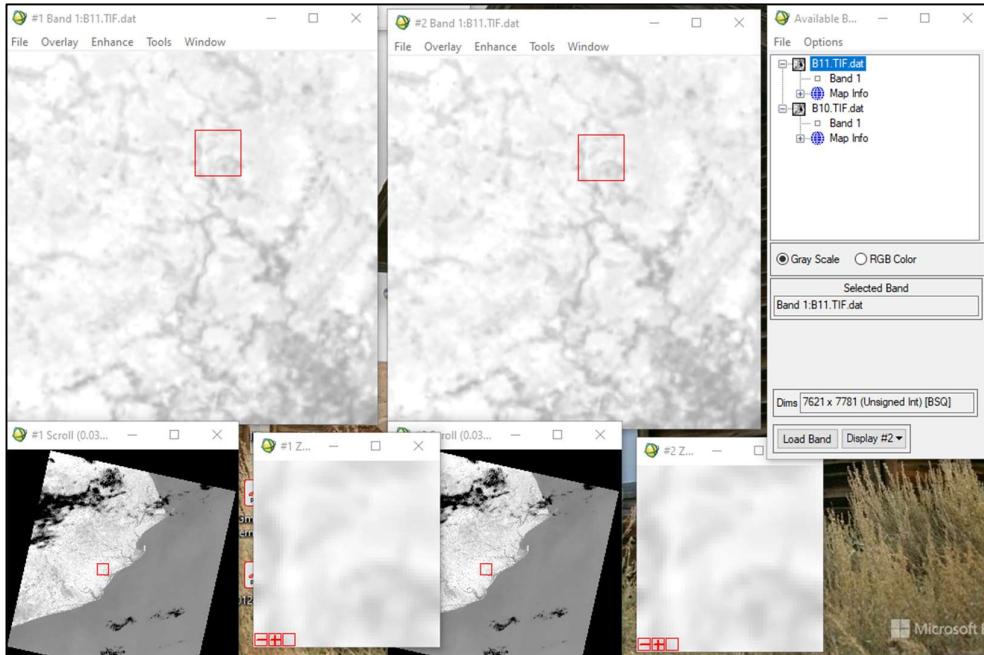
0.303550 , shows Agriculture





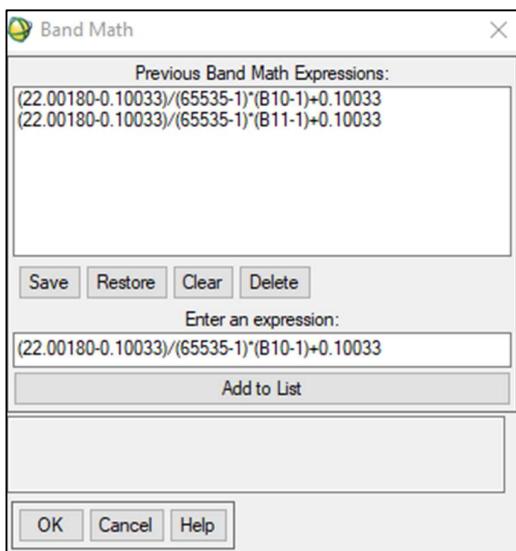
2. Thermal Infrared (TIR) Band

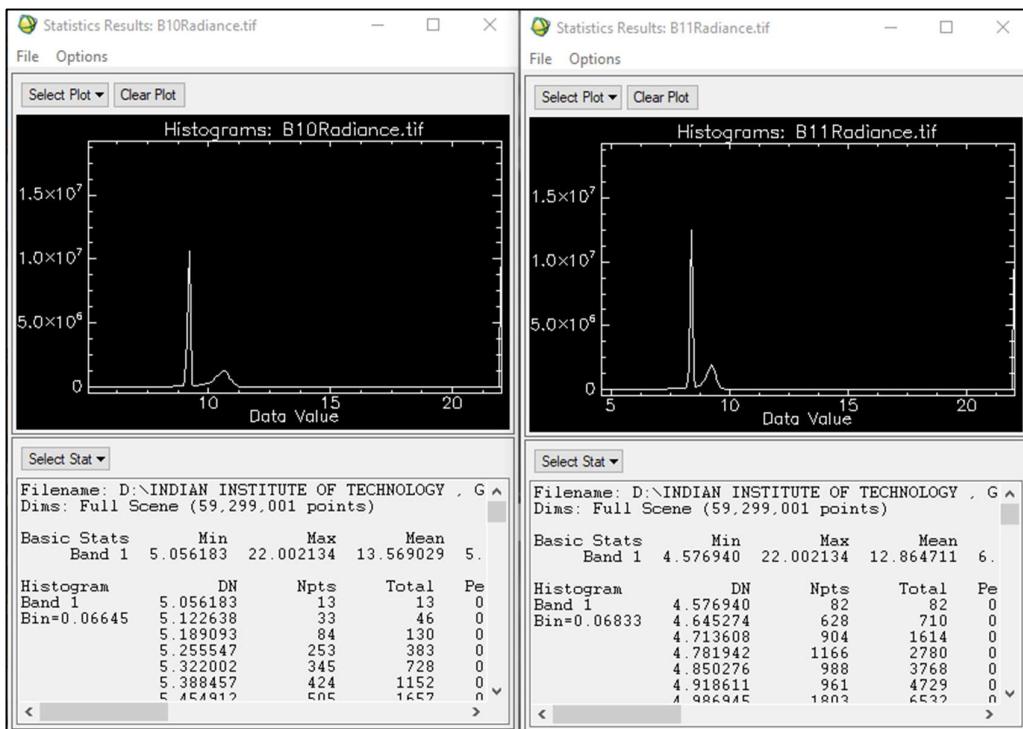
Thermal Infrared (TIR) band measures radiation emitted by objects on Earth's surface, typically in the 5-15 μm spectral range.



```
RADIANCE_MAXIMUM_BAND_10 = 22.00180
RADIANCE_MINIMUM_BAND_10 = 0.10033
RADIANCE_MAXIMUM_BAND_11 = 22.00180
RADIANCE_MINIMUM_BAND_11 = 0.10033
```

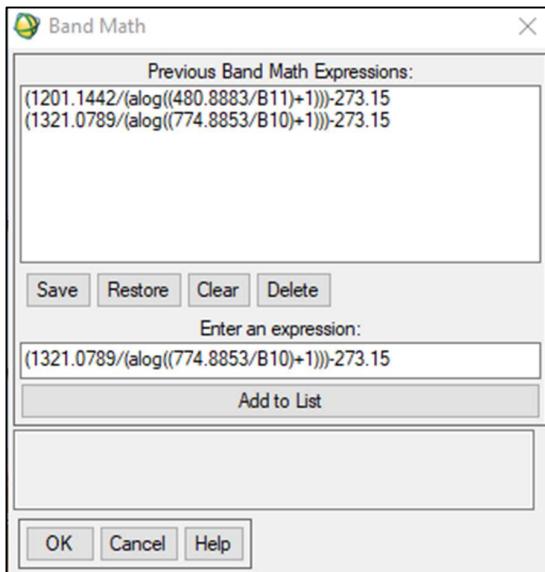
DN to Radiance Conversion

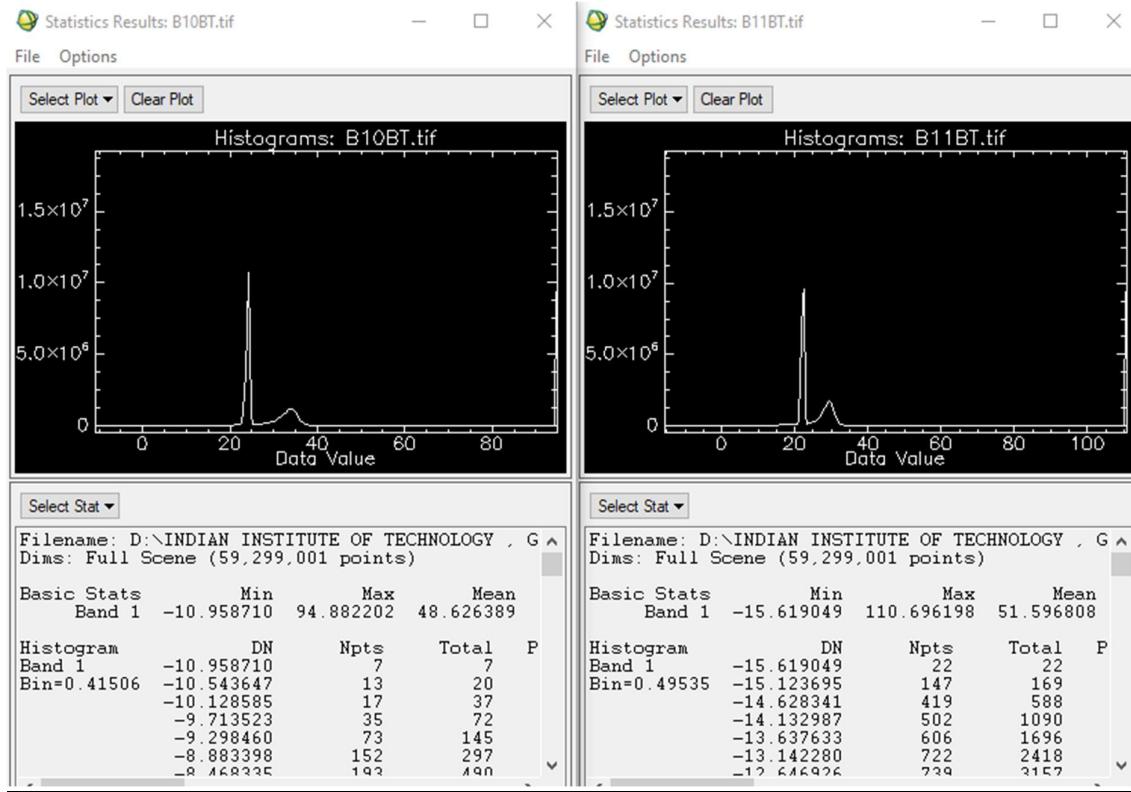




Brightness Temperature (Tb)

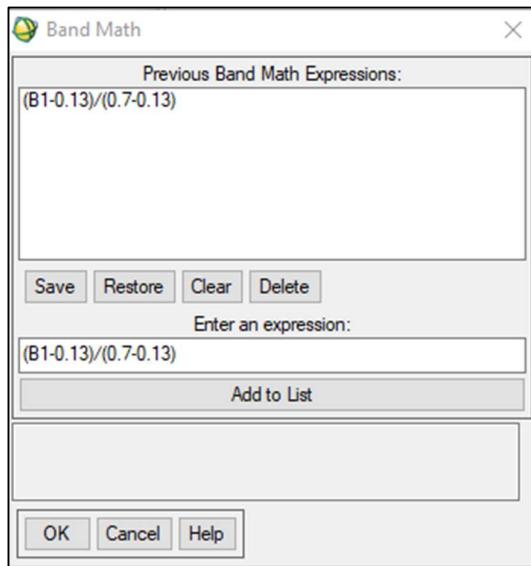
```
GROUP = LEVEL1_THERMAL_CONSTANTS
K1_CONSTANT_BAND_10 = 774.8853
K2_CONSTANT_BAND_10 = 1321.0789
K1_CONSTANT_BAND_11 = 480.8883
K2_CONSTANT_BAND_11 = 1201.1442
```

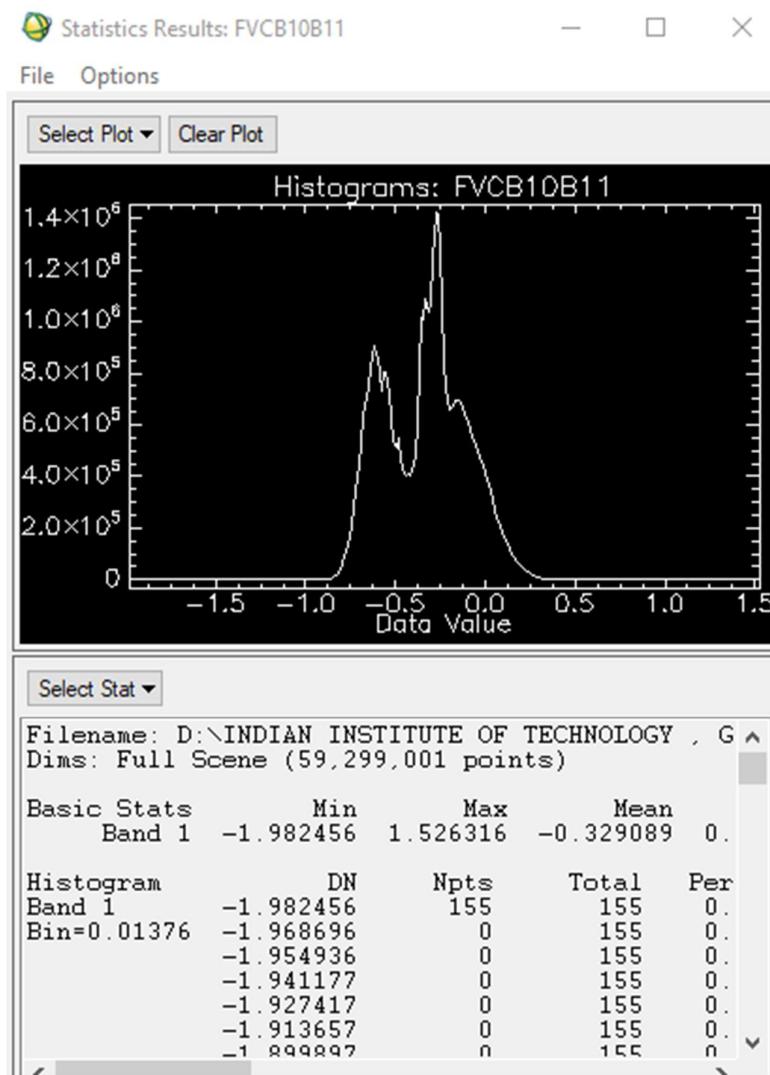




Fractional Vegetation Cover (FVC)

$$\text{FVC} = ((\text{NDVI}-\text{NDVIs})/(\text{NDVIv}-\text{NDVIs}))^2$$





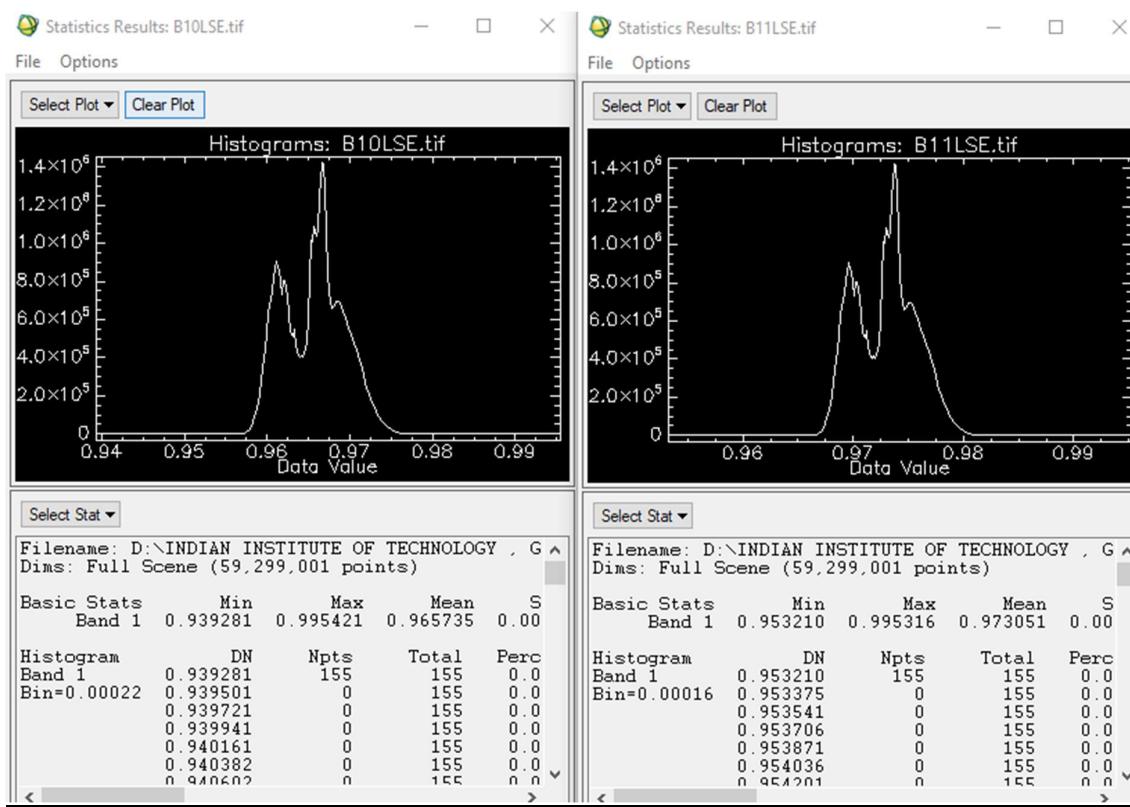
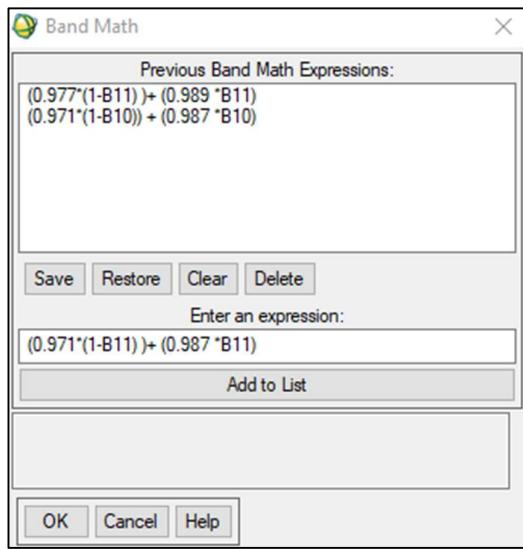
Land Surface Emissivity (LSE)

$$LSE = \epsilon(s) \times (1-FVC) + (\epsilon(v) \times FVC)$$

* $\epsilon(s)$ and $\epsilon(v)$ are band specific soil and vegetation emissivity respectively

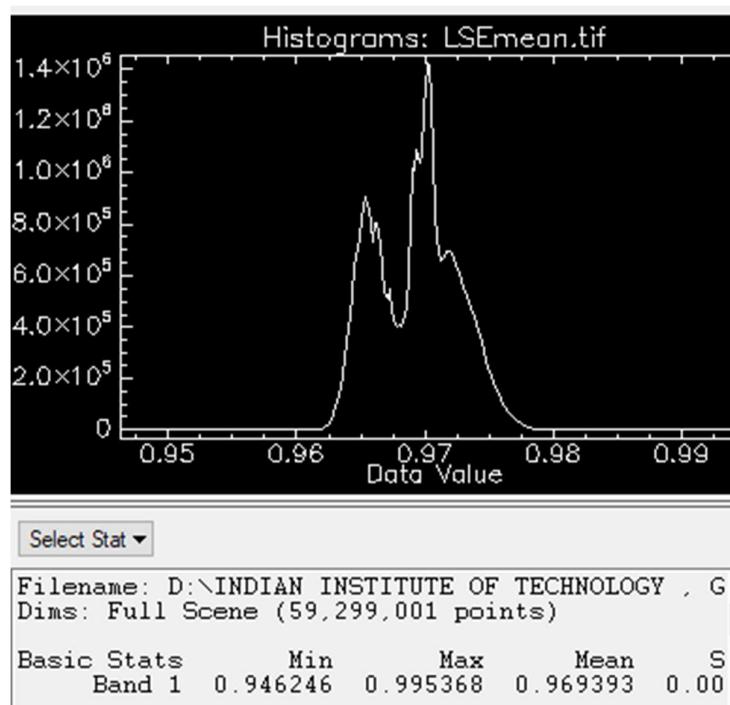
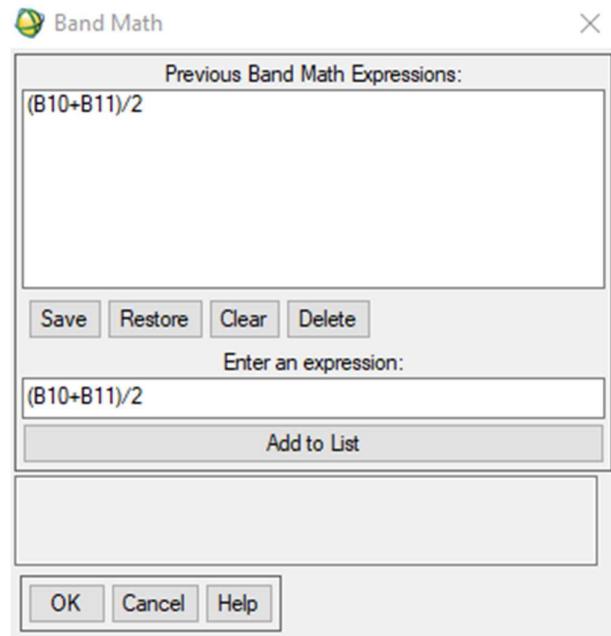
B10: $\epsilon(s)= 0.971$; $\epsilon(v)=0.987$; B11: $\epsilon(s)= 0.977$; $\epsilon(v)=0.989$

$$0.971 \times (1-B10) + (0.987 \times b10)$$



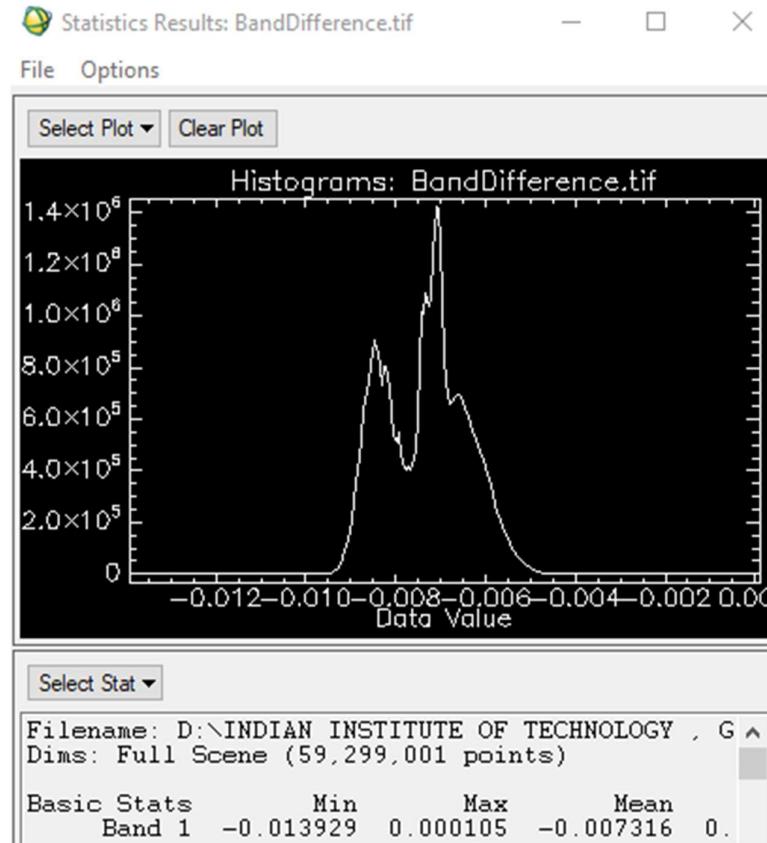
Calculating LSE Mean (m)

$$m = (\text{LSE}(B10) + \text{LSE}(B11))/2$$



Band Difference (Δm)

$$\Delta m = \text{LSE(B10)} - \text{LSE(B11)}$$



Calculating Land Surface Temperature (LST)

$$LST = Tb10 + C1(Tb10 - Tb11) + C2(Tb10 - Tb11)^2 + C0 + (C3 + C4w)(1-m) + (C5 + C6w) \times \Delta m$$

C - Split-window coefficient values

$C0 = -0.268$; $C1 = 1.378$; $C2 = 0.183$ $C3 = 54.300$; $C4 = -2.238$; $C5 = -129.200$; $C6 = 16.400$;

m = mean; Δm = difference; w (water vapor content) = 0.013

$$B10 + 1.378 * (B10 - B11) + 0.183 * (B10 - B11)^2 - 0.268 + (54.300 - 2.238 * 0.013) * (1 - B1) + (-129.200 + 16.400 * 0.013) * B2$$

