Estimation of Land Surface Temperature from Landsat 8 OLI and TIRS

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Course: GEOS 3030
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Due Date: December 1st, 2016

Overview

- Introduction
- Process/Steps taken to complete this lab
- Results
- Discussion

Introduction of Project

- The purpose of doing this lab is so that we gain experience using the NDVI method in calculating surface emissivity and also surface temperature from the Landsat 8 TIRS data.
- We are looking at thermal change detection of the study area of our choosing to produce the deliverable for this lab.
- The software that was used in the processing of this data will be ArcMap 10.4
- The study area that we will be working with is the Loma Prieta, which can be found South of San Jose, California.
- Please note all figures/numbers that are found throughout this process can be found within the metadata, which is a text file that comes with the data when it is downloaded.

Background on Loma Prieta

- *"Loma Prieta is a 3,790 feet Northern California mountain in the Santa Cruz Mountains. The peak is on private property about 11 miles west of Morgan Hill in Santa Clara County"* *https://www.google.com/maps/place/Loma+Prieta/@37.1238111,-121.8480761,19430m/data=!3m1!1e3!4m5!3m4!1s0x808e3b654a56b153:0xecb3721fcb2e9b2d!8m2!3d37.1107806!4d-121.8446761?hl=en-CA*

Loma Fire Incident Information:	
Last Updated:	October 12, 2016 6:00 pm FINAL
Date/Time Started:	September 26,2016 2:42 pm
Administrative Unit:	CAL FIRE Santa Clara Unit
County:	Santa Clara County
Location:	off Loma Prieta Rd and Loma Chiquita Rd 10 miles NW of Morgan Hill
Acres Burned - Containment:	4,474 acres - 100% contained
Structures Destroyed:	12 single residence and 16 outbuildings destroyed, 1 single residence damaged
Evacuations:	All evacuation orders and road closures issued by the Loma Fire Incident have been lifted. **The Morgan Hill Evacuation Center is closed:**
Cause:	Under investigation
Cooperating Agencies:	California Highway Patrol, Santa Clara County Sheriff’s Office, Santa Cruz County Sheriff’s Office, California Department of Corrections and Rehabilitation, San Jose Water Company, Santa Clara Valley Water District, Pacific Gas and Electric and Santa Clara County Office of Emergency Services, California Conservation Corps, Red Cross, Santa Clara County Fire Safe Council, Santa Clara County Parks, Santa Clara County Open Space District, and Mid-Peninsula Open Space District, Santa Clara County Roads and Airports, Santa Cruz Public Works, Pacific Gas and Electric, and Cal OES.
Total Fire Personnel:	62
Total Fire Engines:	3
Total Fire Crews:	1
Total Dozers:	1
Total Water Tenders:	5
Long/Lat:	-121.85318/37.10632
Conditions:	Fire crews remain throughout the fire perimeter to provide fire suppression repair, remove firefighting equipment, mop up and patrol. Please drive slowly and use caution as emergency crews and equipment are still working in the area. See the State's Post Fire Watershed Emergency Response Report.

- Here is some information about the fire and some of the damage it caused.
- http://www.fire.ca.gov/current_incidents/incidentdetails/Index/1457

Step One

- Choose a scene that interest you and that has had some recent thermal activity.
- Once you have chosen your study area then download your Landsat 8 OLI and TIRS data (Please note that the data downloaded for this lab was downloaded from USGS Earth Explorer).
- You must choose and download a before & after scene to complete this thermal change detection.

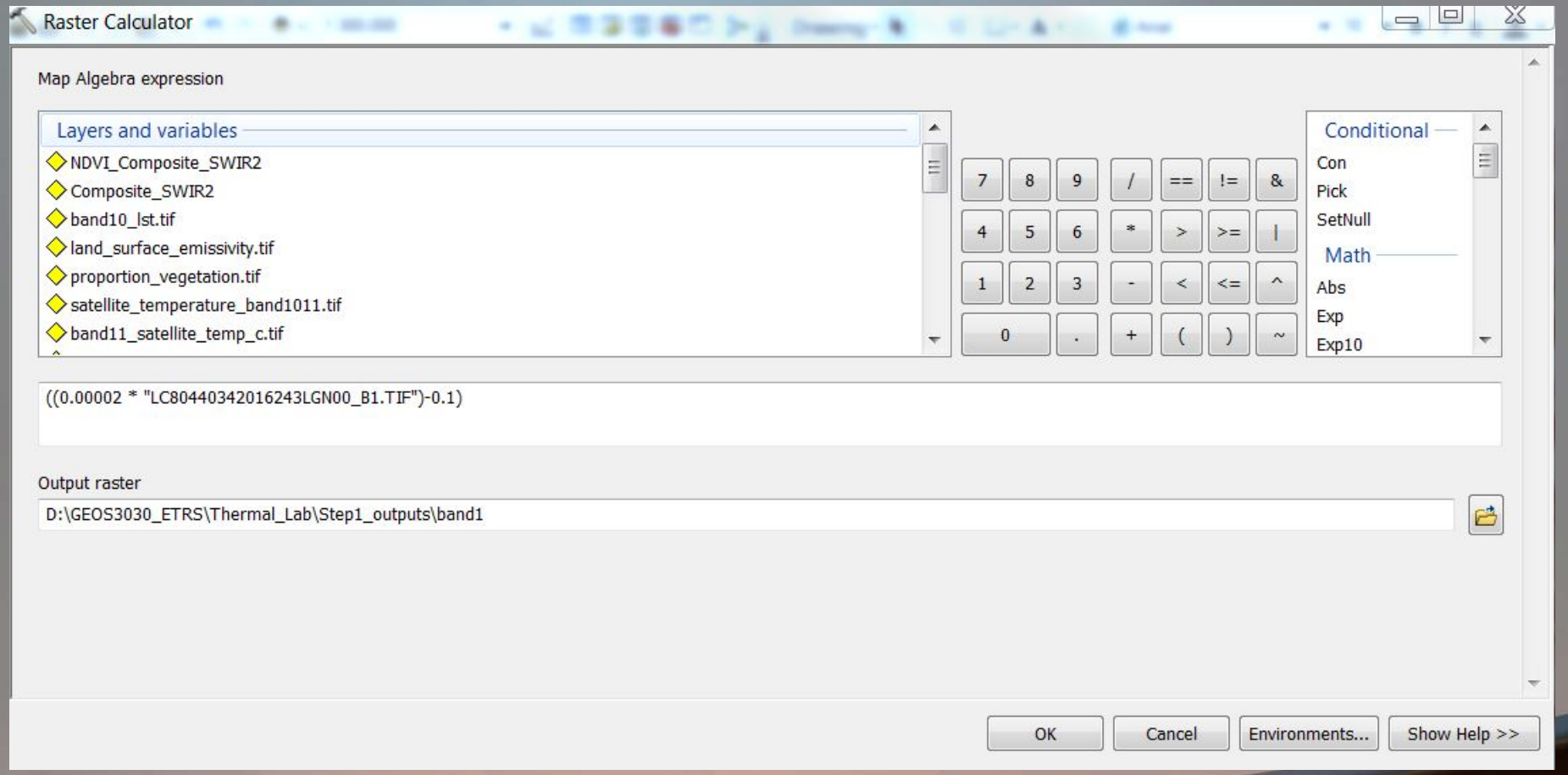
Step Two

- Once you have your data downloaded and unzipped (both scenes; before & after). The next step is to Atmospherically correct your imagery.
- The equation that was used to Atmospherically correct the imagery is as follows:

  Band specific reflectance_mult_band *DN values + reflectance_add_band

- The following slide contains an image that shows how this equation is applied to the images by using the Raster Calculator, found within ArcMap.

Step Two Image



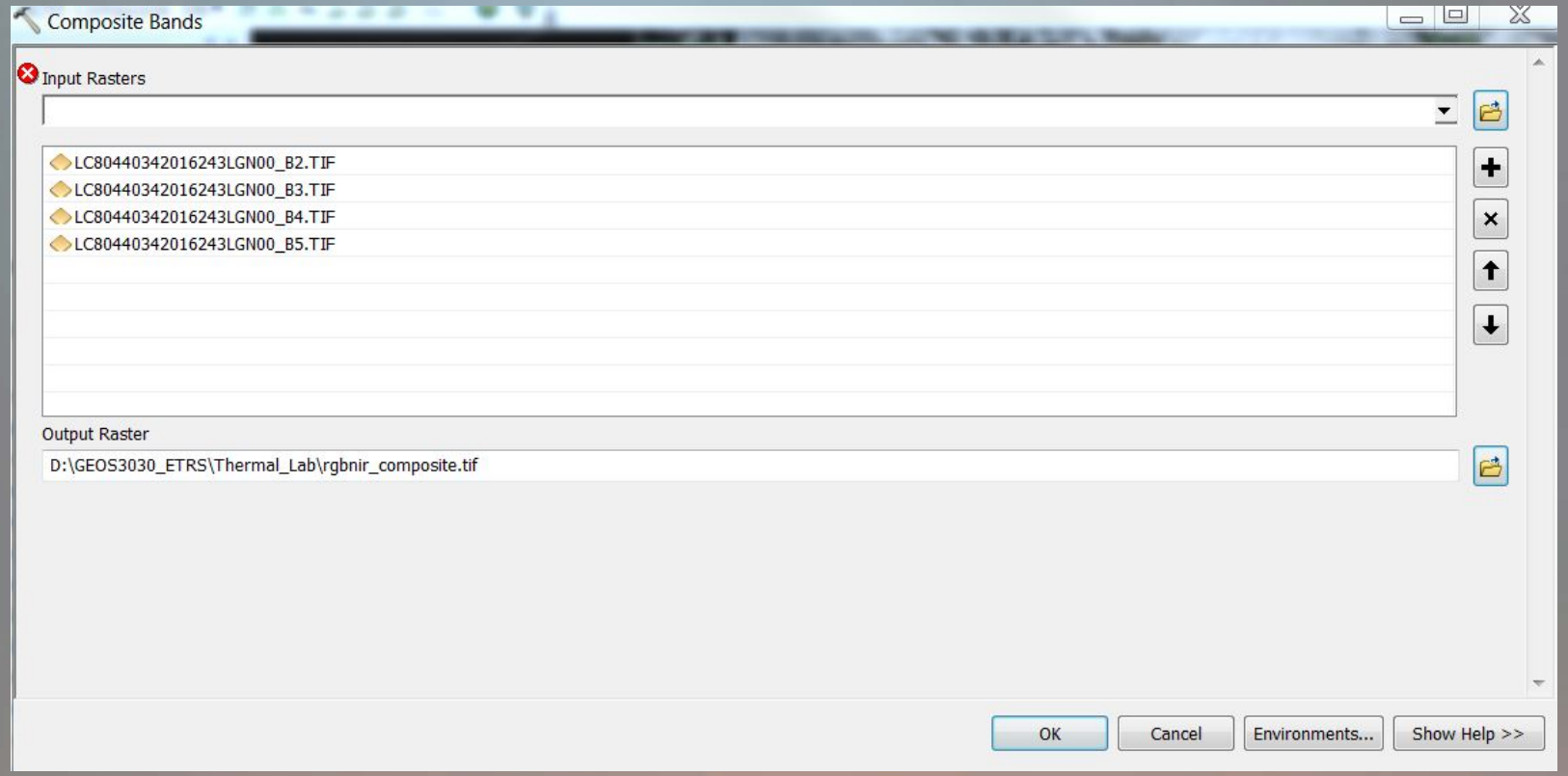
Step Three

- This step requires you to display bands 4 (red), band 5 (Near Infrared (NIR)), and band 7 (Short-wave Infrared (SWIR)) within ArcMap 10.4

Step Four

- This step asks you to use the composite bands tool, found within ArcMap 10.4.
- The four bands that you will used to run this tool will be bands two, three, four, and five.
- The following two slides show the tool, how to set it up and also what the output looks like after the tool has run successfully.

Step Four Image of Tool



Step Four Output

Before Fire Image (Taken August 30th, 2016)

After Fire Image (Taken November 10th, 2016)

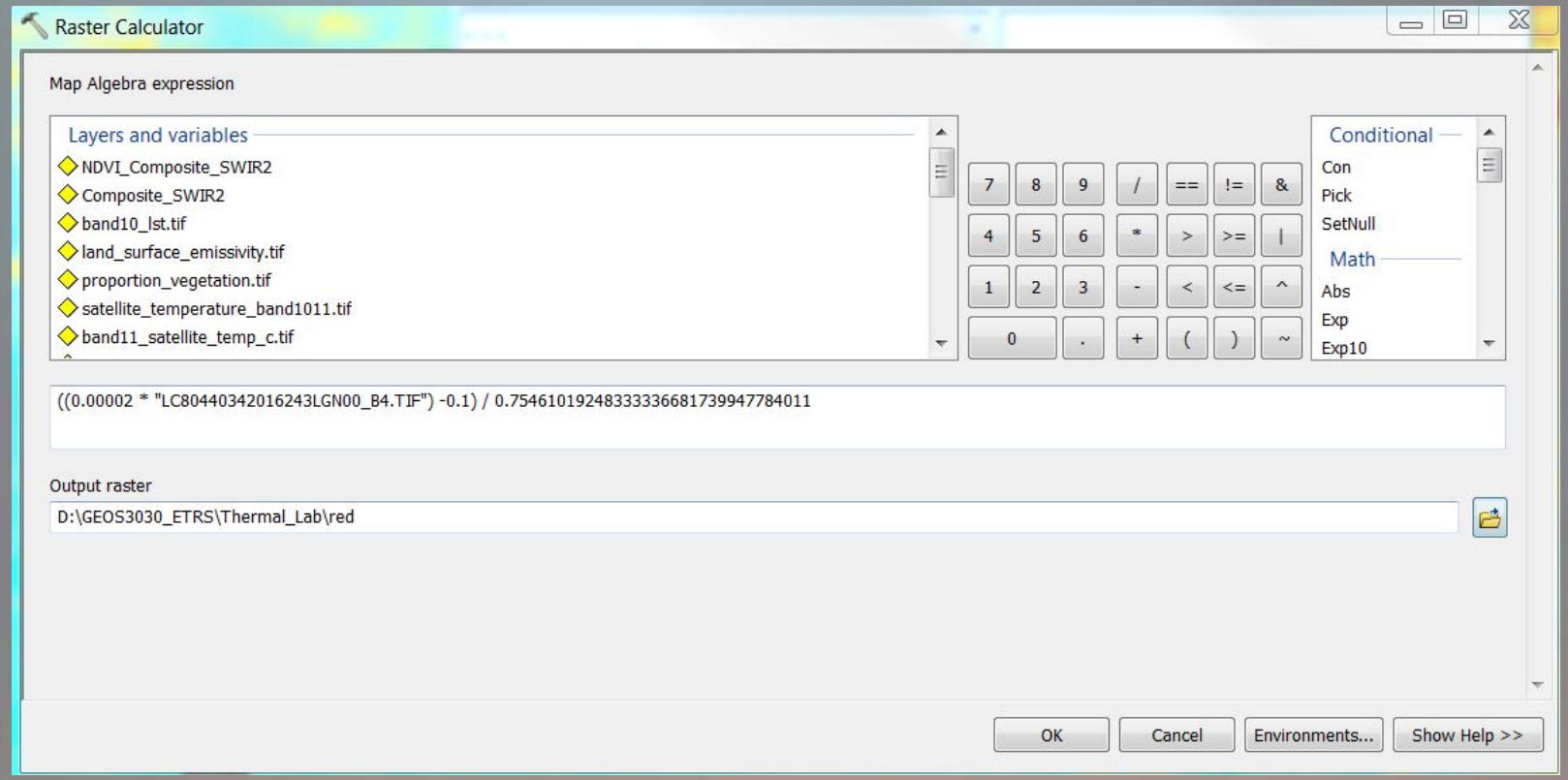
Step Five

- After you have combined bands two, three, four, and five together the next step is to open up Raster Calculator again and use the following equation to “roughly” atmospherically correct the Red (4), NIR (5) and SWIR (6 & 7) bands.

  Band specific reflectance_mult_band *DN values + reflectance_add_band / sin (sun elevation)

- The following slide contains an image that shows how this equation is applied to the images by using the Raster Calculator, found within ArcMap.

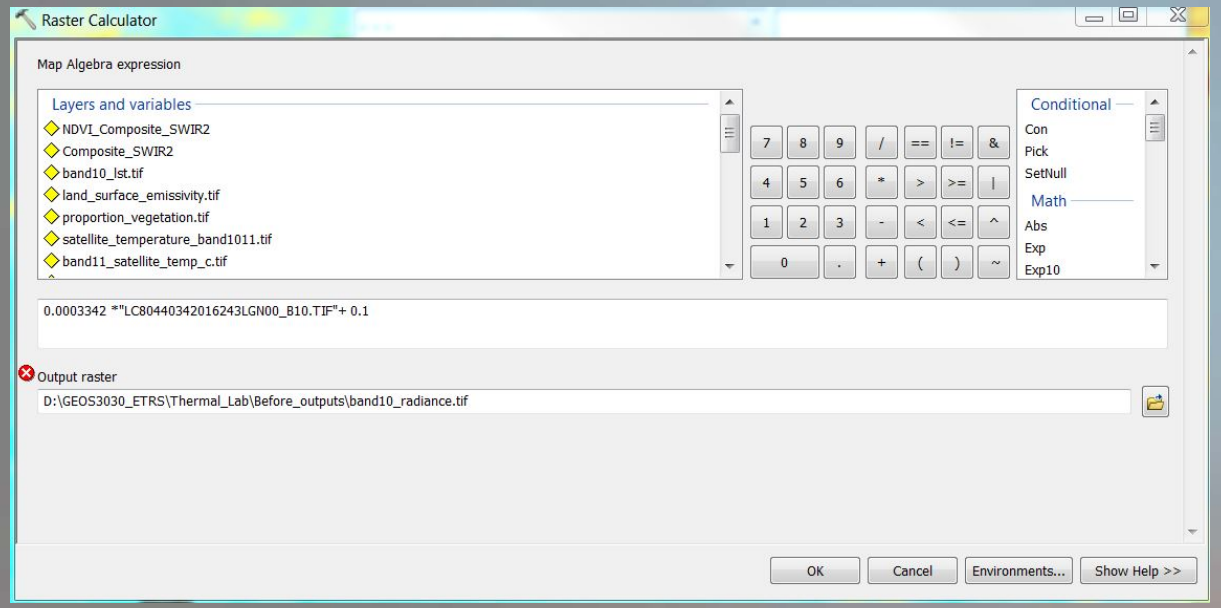
Step Five – Raster Calculator

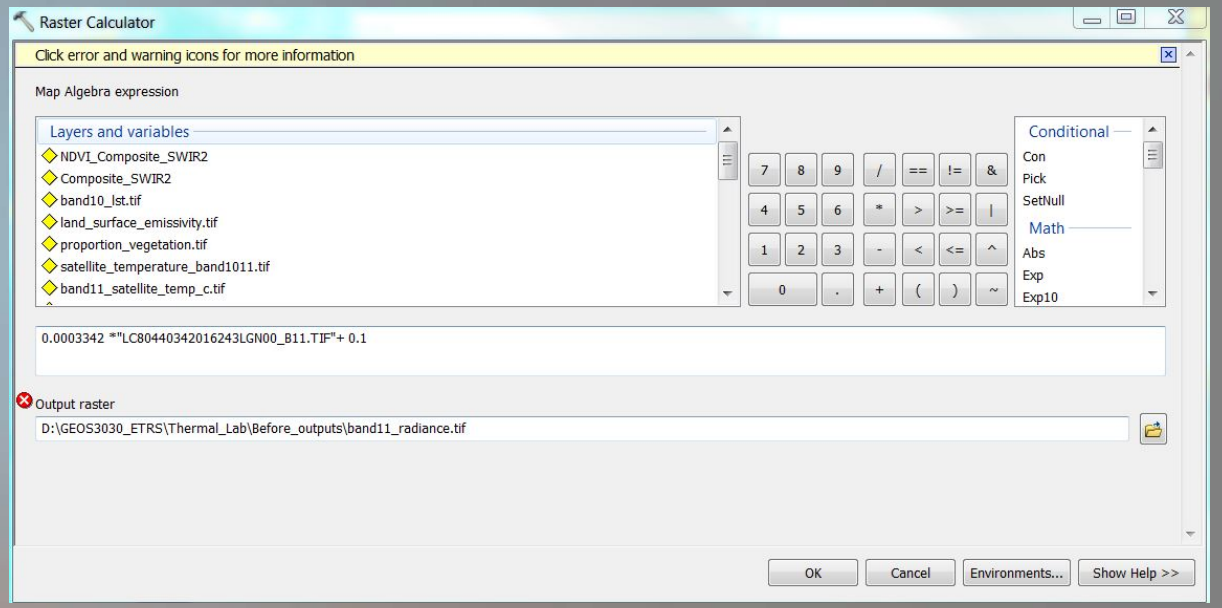


Step Six

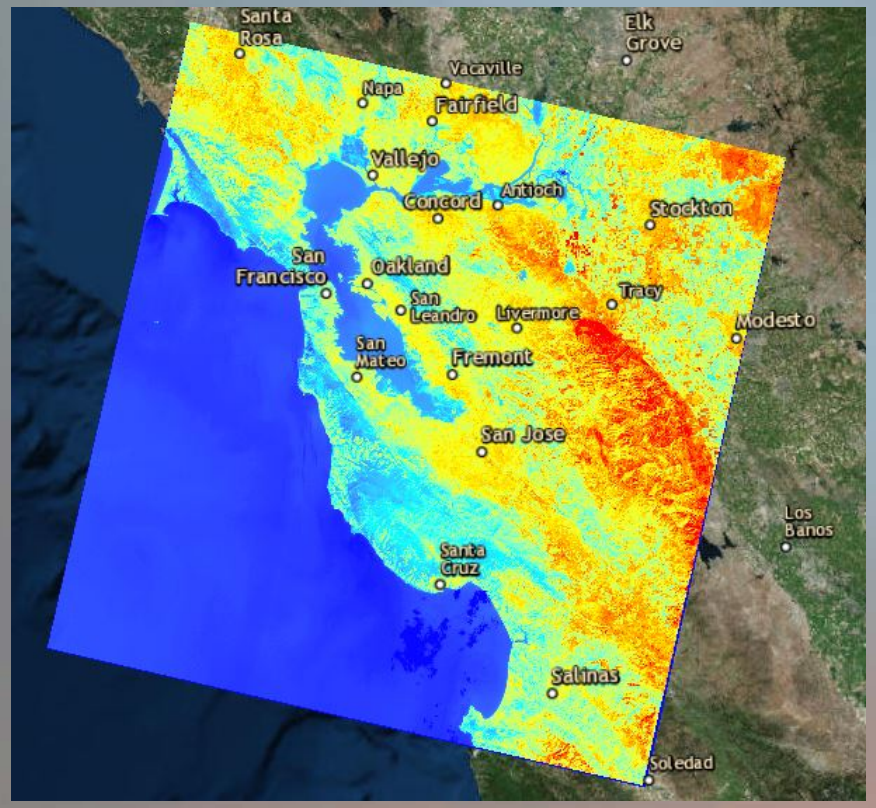
- This step is mainly for conversion of digital numbers to at satellite radiance.
- During this step you are adding band 10 and band 11 to your ArcMap display. Using raster calculator you use the following equation for both bands (10 & 11).
- 0.0003342 * "LC80090292014248LGN00_B10.TIF" + 0.1
- 0.0003342 * "LC80090292014248LGN00_B11.TIF" + 0.1
- The following slide shows what the equation looks like within raster calculator.

Step Six – Raster Calculator





Step Six - Output

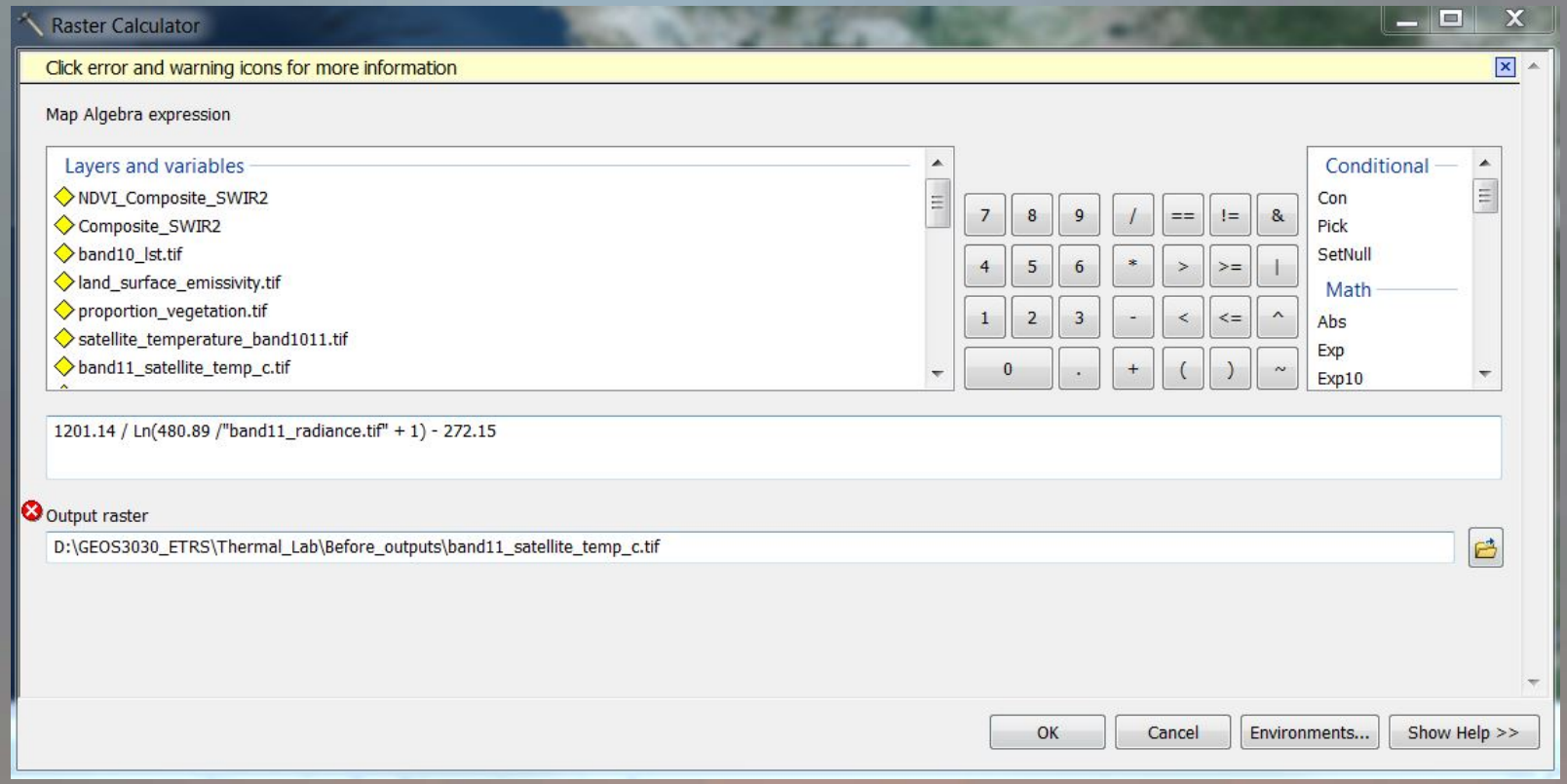


- This output image is that of band10_radiance

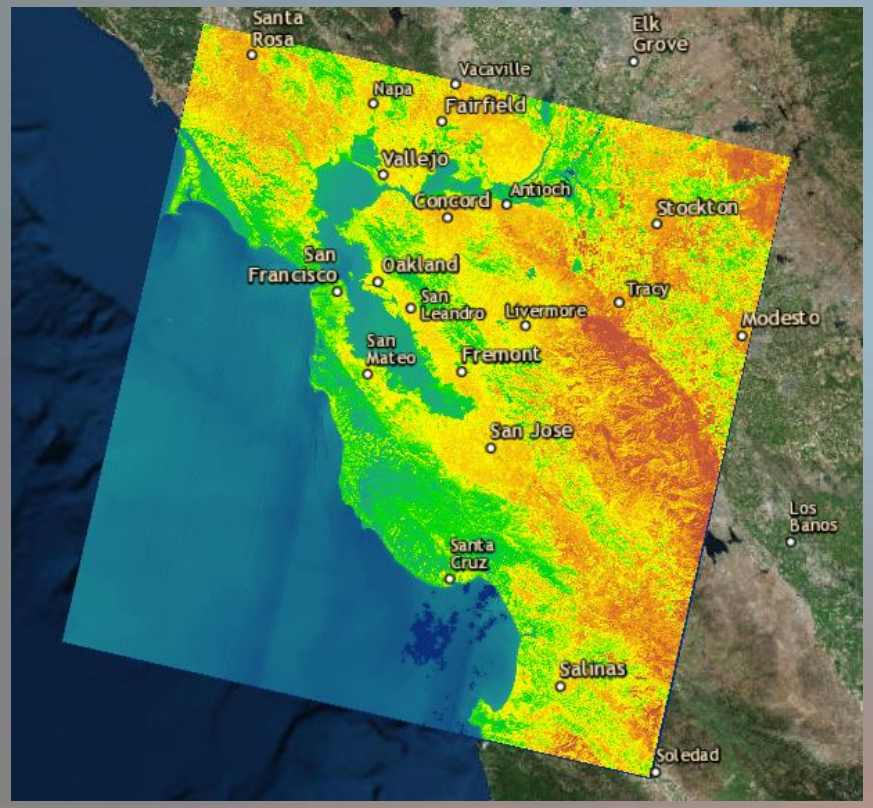
Step Seven

- For this step you are conversion to At-Satellite Brightness Temperature.
- Open raster calculator and put in the following equation:
- 1321.08 / Ln(774.89 / "band10_radiance.tif" + 1) - 272.15

Step Seven- Raster Calculator



Step Seven – Output

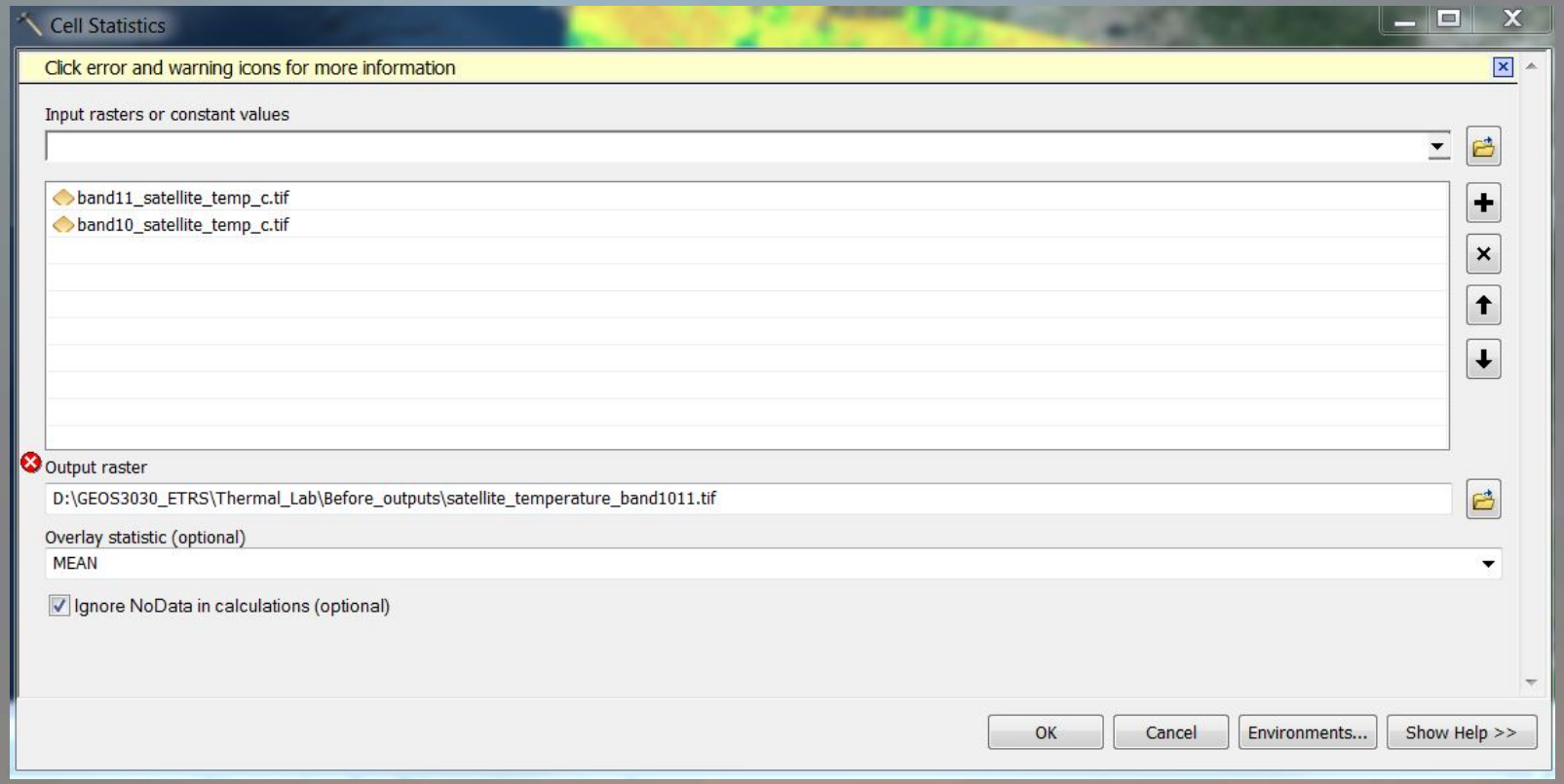


- This output image is that of band11_satellite_temp_c

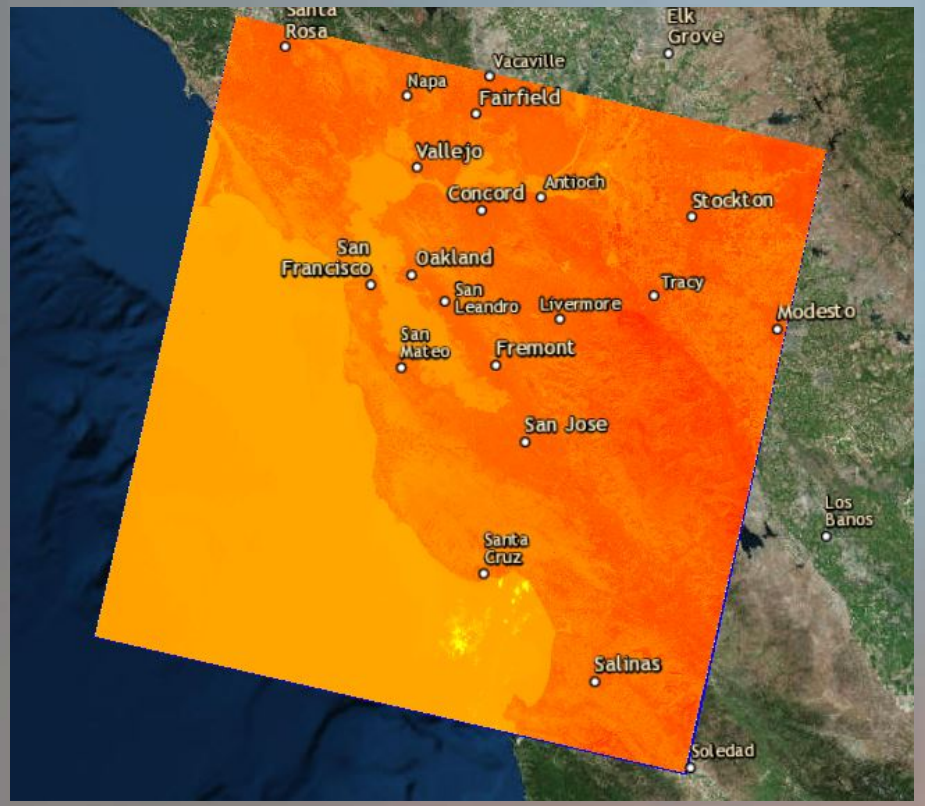
Step Eight

- The next step is to use the cell statistics tool, by using the output from the pervious step as the input rasters. The output of this tool will create an average temperature raster.
- The following two slides show what the cell statistics tool looks like before you run the tool and then the following slide will be showing the output of the tool.

Step Eight – Cell Statistics



Step Eight – Output



- This output image is that of satellite_temperature_band1011

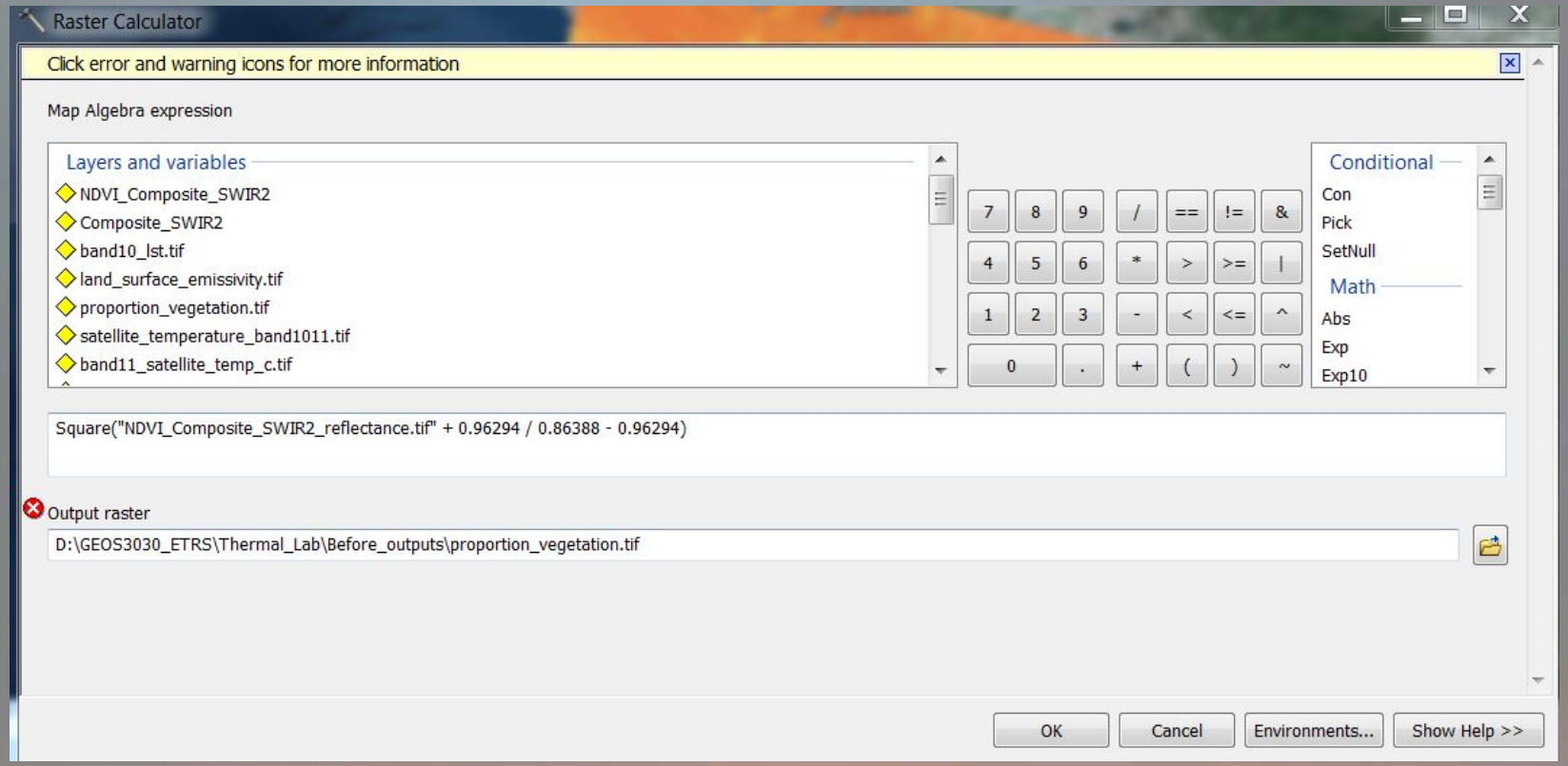
Step Nine

- In order to calculate the land surface emissivity the first step is to calculate the proportion of vegetation by using the raster calculator, once again, and the equation that can be found below.

- Square("NDVI_Composite_swir_reflectance.tif" + 0.96294 / 0.86388 - 0.96294)

- The following slide is showing the raster calculator

Step Nine – Raster Calculator



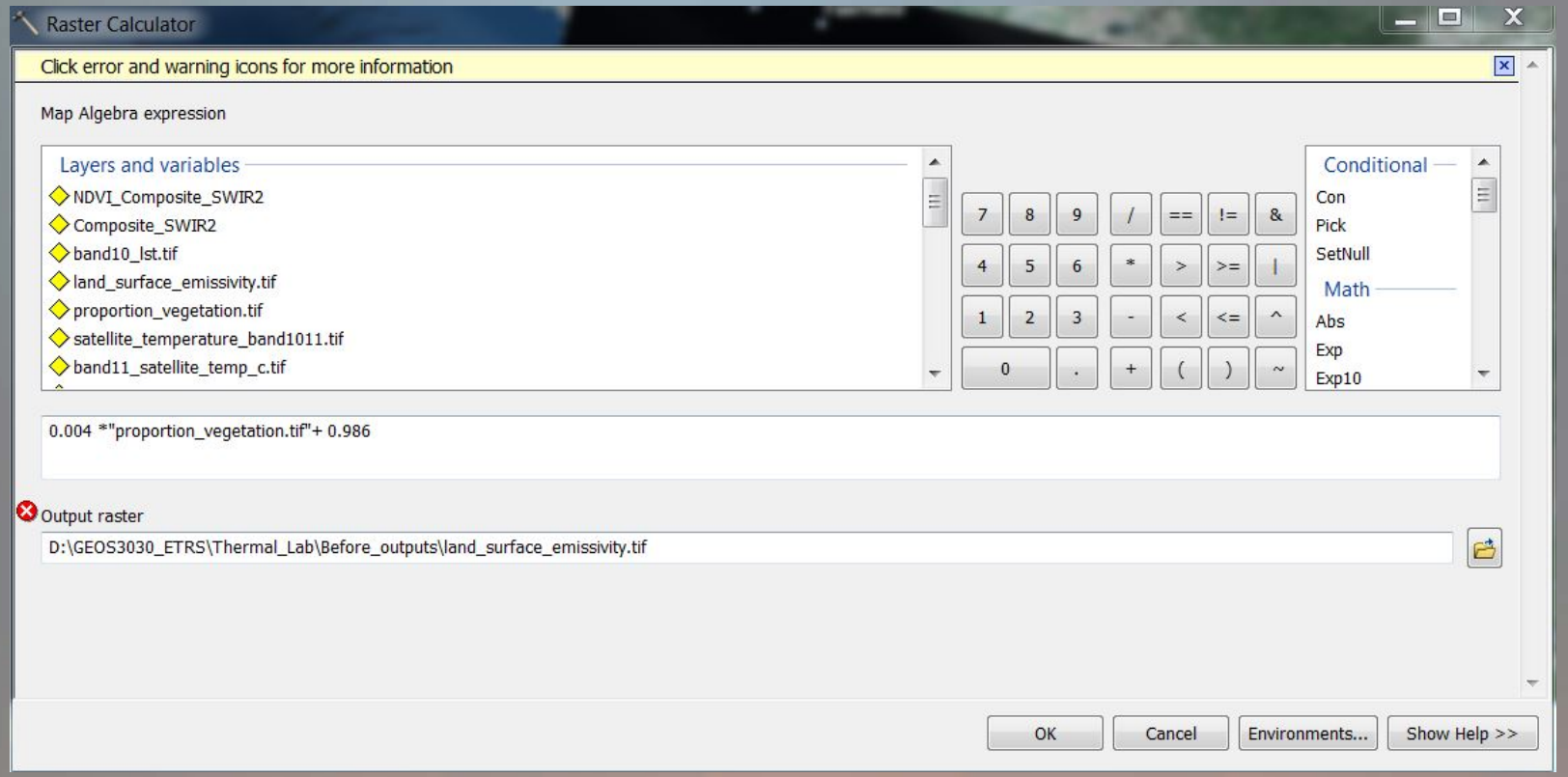
Step Ten

- In this second to last step you are going to calculate for emissivity.
- This is done by using the following equation and raster calculator.

- 0.004 * "proportion_vegetation.tif" + 0.986

- The following slide is showing what the raster calculator looks like

Step Ten – Raster Calculator



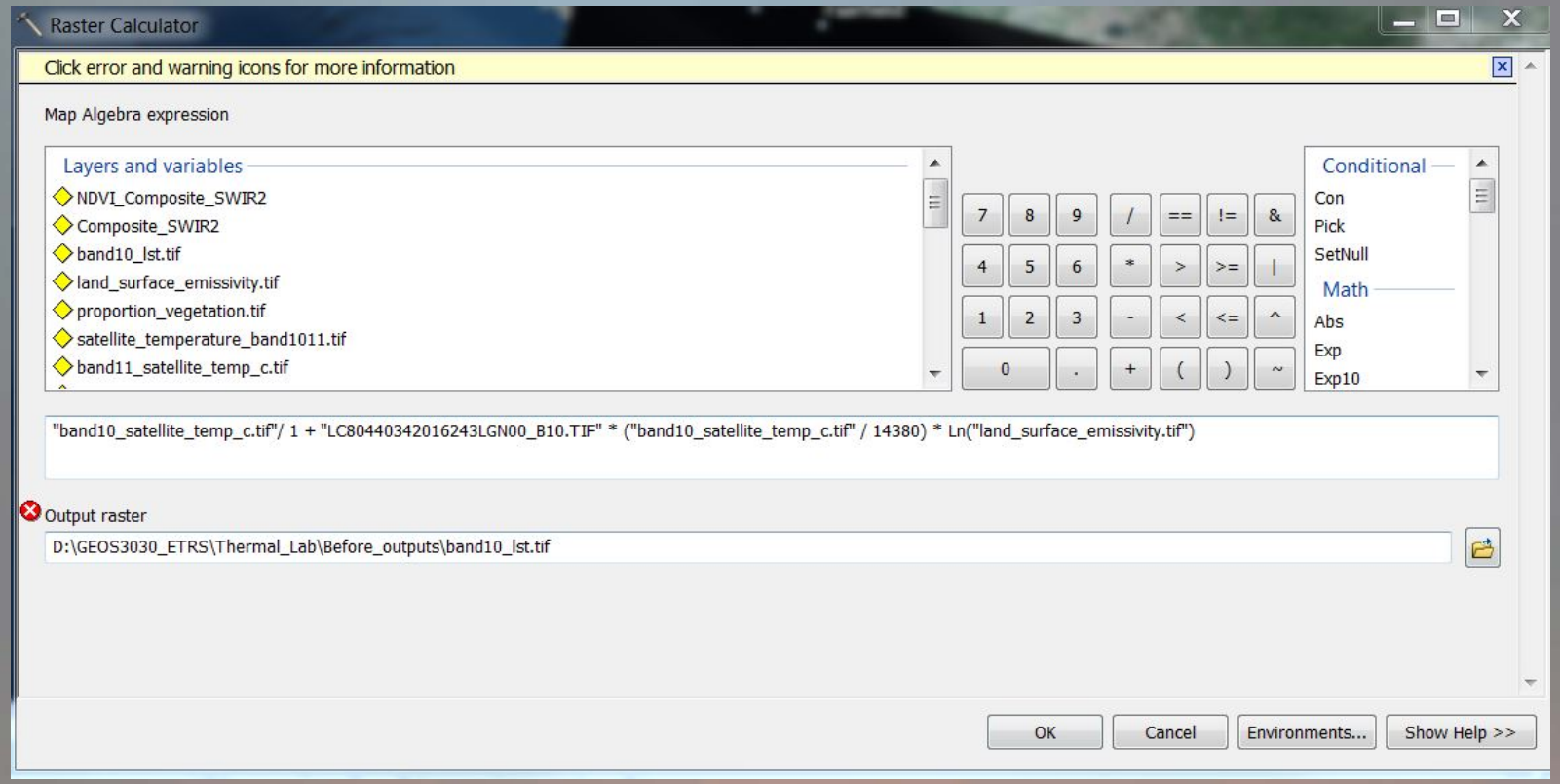
Step Eleven

- The following equation is what will be used to calculate the land surface temperature. This will be put into, yet another, raster calculator.

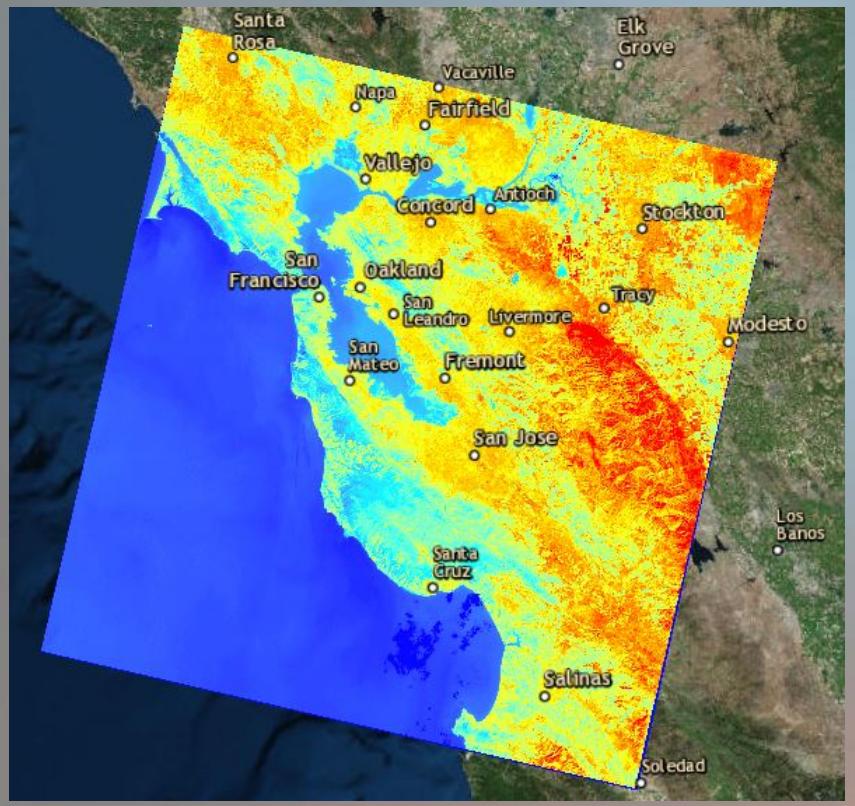
- "band10_satellite_temp_c.tif" / 1 + "LC80090292014248LGN00_B10.TIF" * ("band10_satellite_temp_c.tif" / 14380) * Ln("land_surface_emissivity.tif")

- The following slides are showing the raster calculator and the output of the final process.

Step Eleven – Raster Calculator



Step Eleven - Output

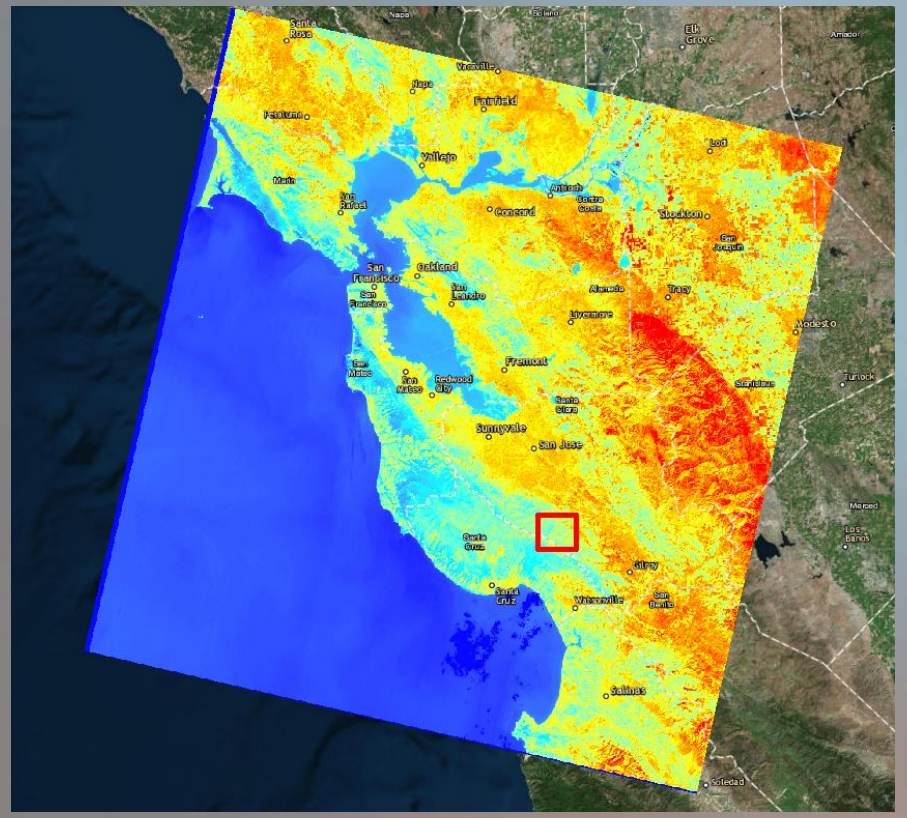


- This output image is that of band10_lst

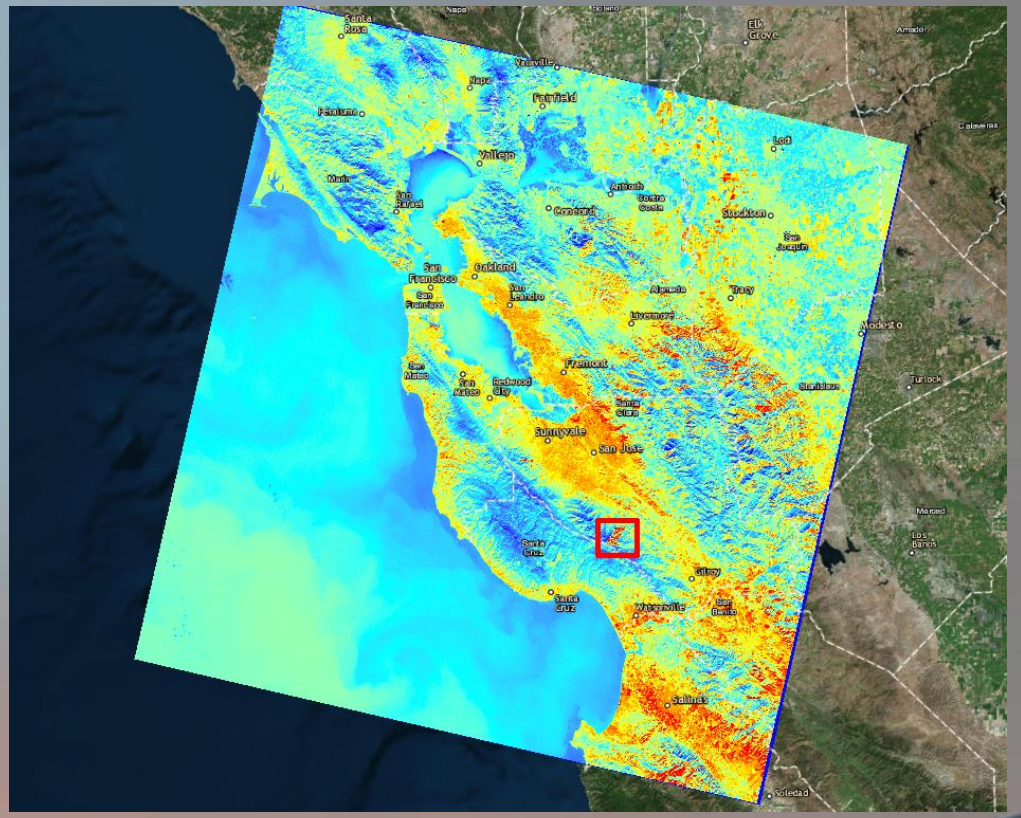
Repeat Process

- Once you have completed this process once, you then have to do it again. This is due to the fact that you need to do the process for both before and after images of the fire.

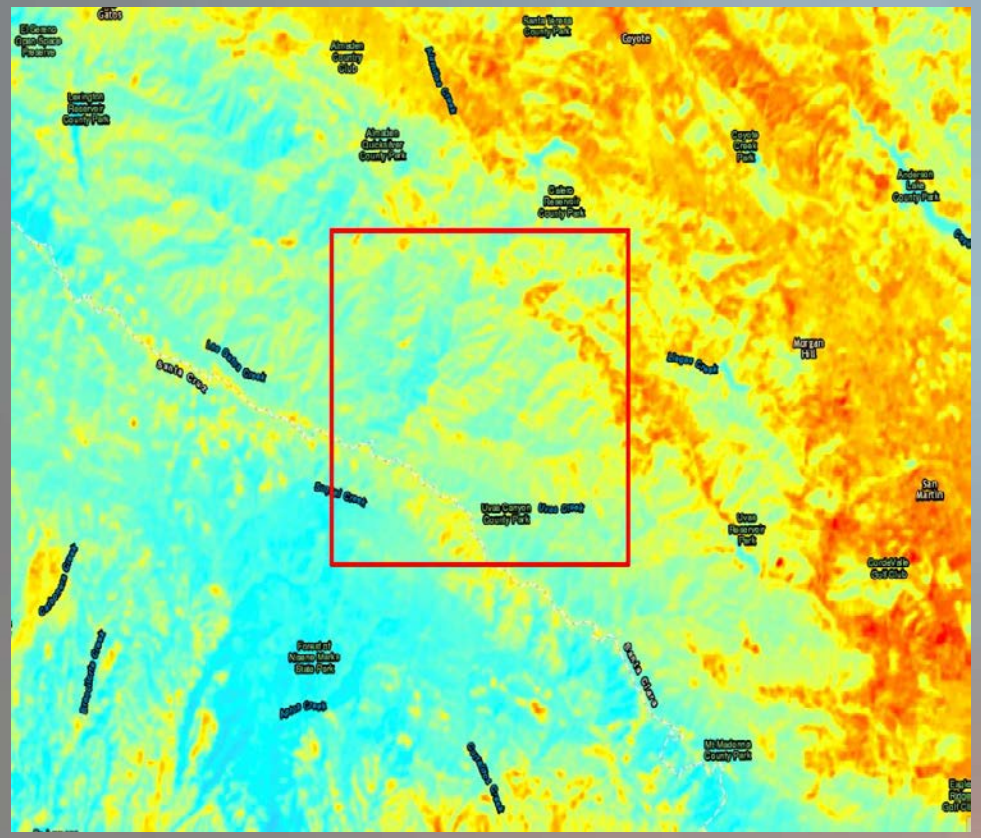
Before Fire



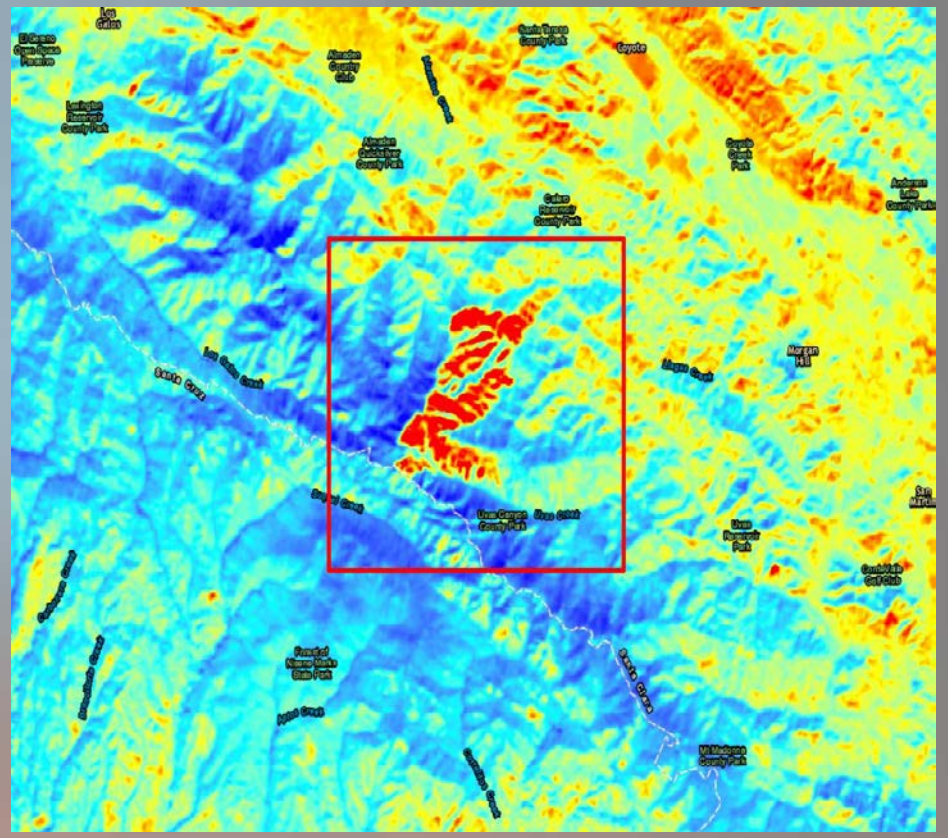
After Fire



Before Fire



After Fire



Sources

- The data that was used from this lab was gathered from USGS Earth Explorer http://earthexplorer.usgs.gov/
- The two files that were downloaded are as follows: LC80440342016243LGN00.tar and LC80440342016323LGN00.tar
- The software that was used to process the data was ArcMap 10.4
- http://en.climate-data.org/location/6398/ This is where I found the historical weather data for San Jose (table near the bottom of the page).