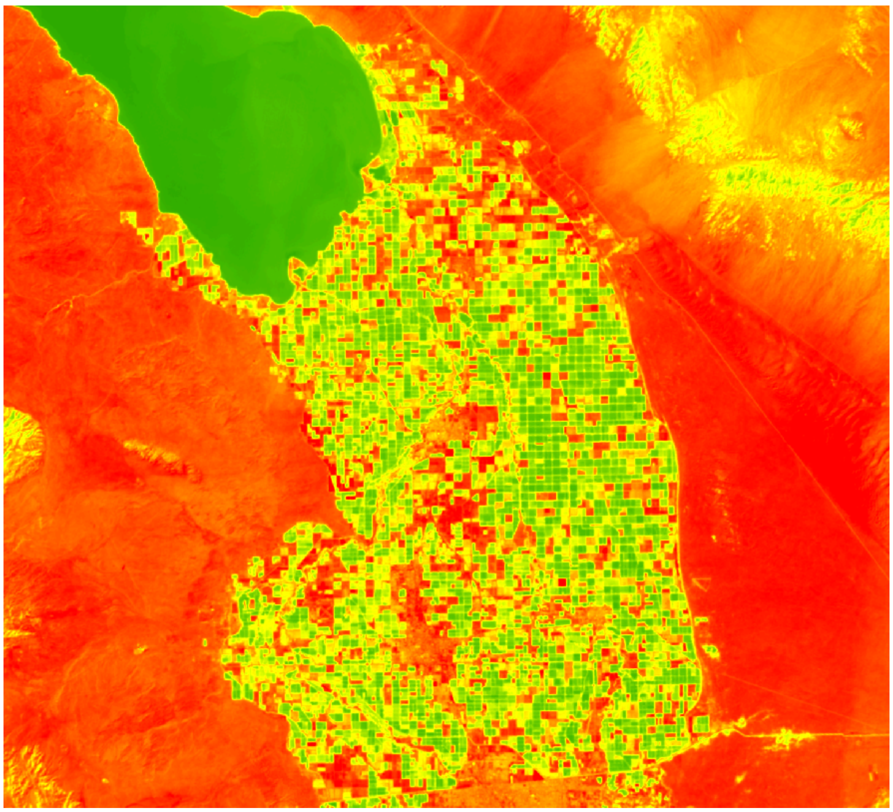
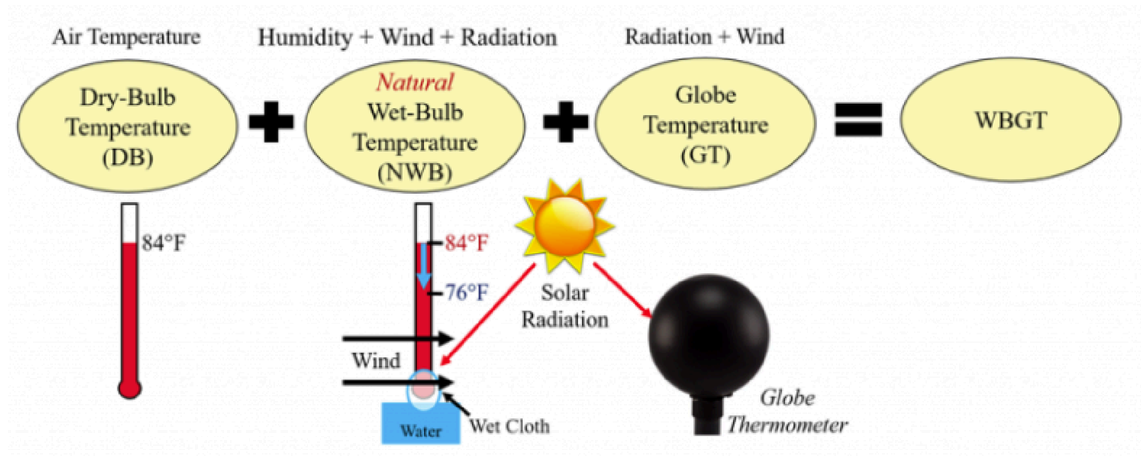
Stephanie Hurtado
GEOG 688L
4/25/24

Week 14: Thermal imaging using satellite imagery from Landsat





$$WBGT = 0.1 * DB + 0.7 * NWB + 0.2 * GT$$

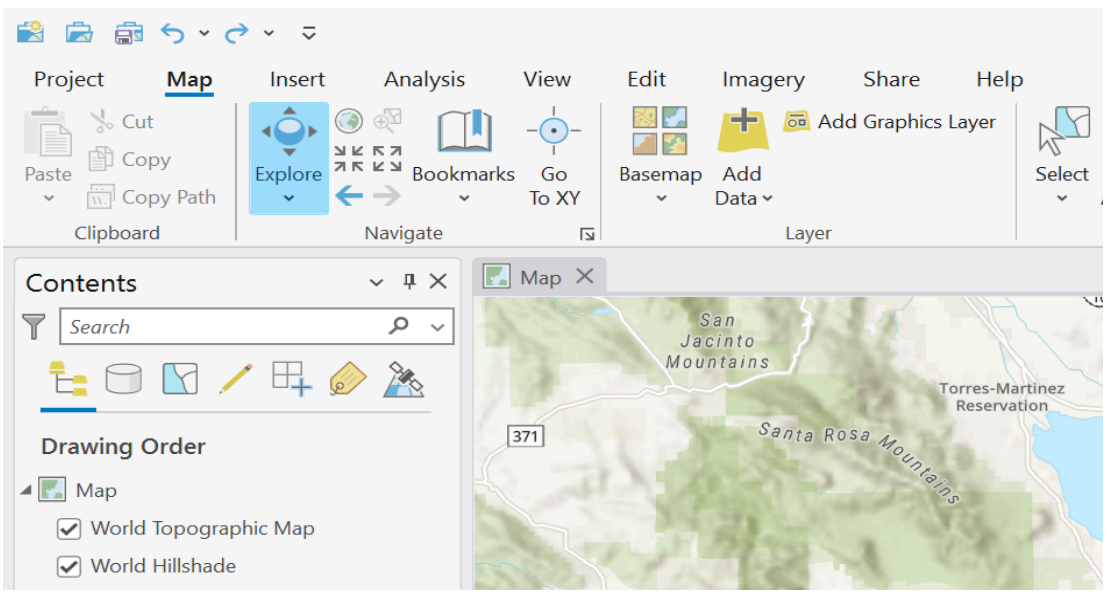
Background:

- Location: Imperial Valley, California

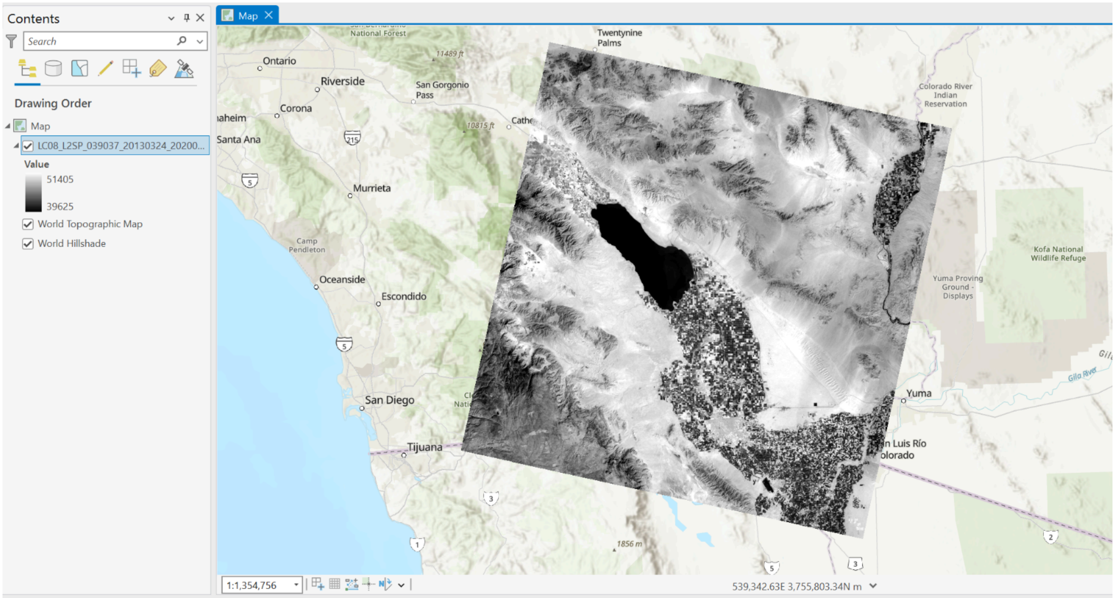
- Huge agricultural grower and most noticeably known for being the largest producer of winter vegetable crops
- Desert climate: can easily exceed 100°F from mid-spring into the summer months
- Analyzed the relationship between land surface temperature (LST) and air temperature (Tair). How well can remote sensing LST predict Tair?
- To get reliable statistics cropping the raster images is necessary for a time-series analysis.

Step 1: Making buffers using ArcGIS Pro

1. Go to my student folder and download the TIF files (3).
2. Open ArcGIS Pro and create a new Project called "landsat_thermal_lab"



3. Click on 'Map' and then 'Add Data' and open up the following TIF file: LC08_L2SP_039037_20130324_20200912_02_T1_ST_B10. It should look like this:



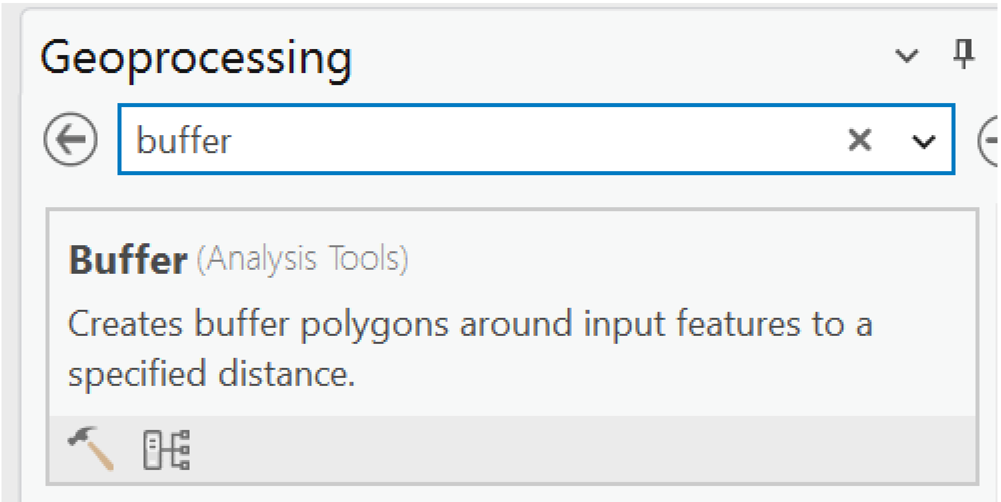
4. Click on ‘Map’ and then click on ‘Go To XY’. You will see a Long and Lat window at the bottom of your screen. Type in the two coordinate points you were assigned to (this will be for visualization purposes). Keep units in decimal degrees.
5. Once you have added your two points unclick ‘Go To XY’.

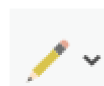
Nowshin: Calipatria & El Centro
Michael: Meloland & Niland
Brenna: Seeley & Sonny Bono
Wes: Westmorland West, Calipatria
Will: Westmorland North, Niland
Ibisia: Calipatria & Sonny Bono
Bruce: Meloland & El Centro
Elise: Seeley & Sonny Bono

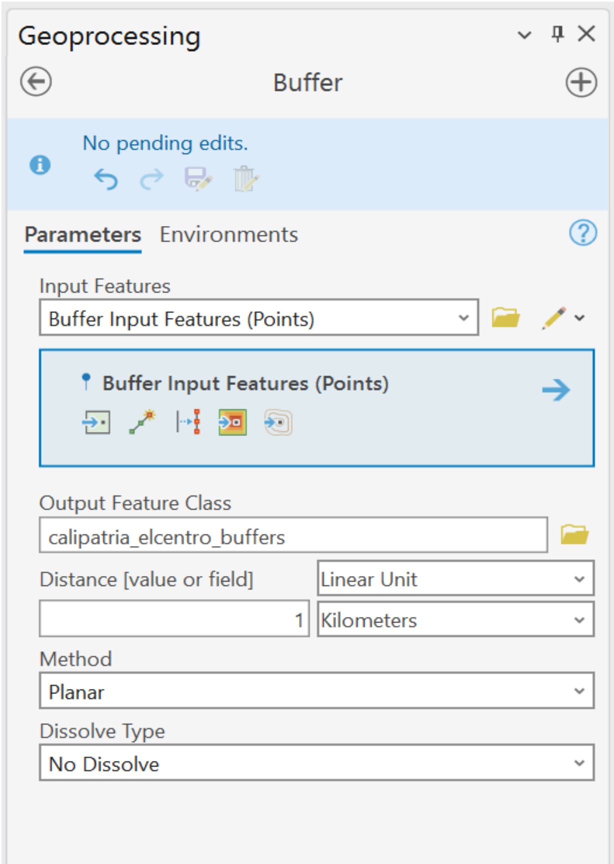
Station	Latitude	Longitude
Calipatria	33.042986	-115.411585
Meloland	32.806183	-115.44626
Seeley	32.759575	-115.73207
Westmorland North	33.078611	-115.66056
El Centro	32.79215	-115.56299
Niland	33.213488	-115.545136
Sonny Bono	33.176383	-115.6231
Westmorland West	33.03239	-115.623618

(screenshot of CSV file located in folder)

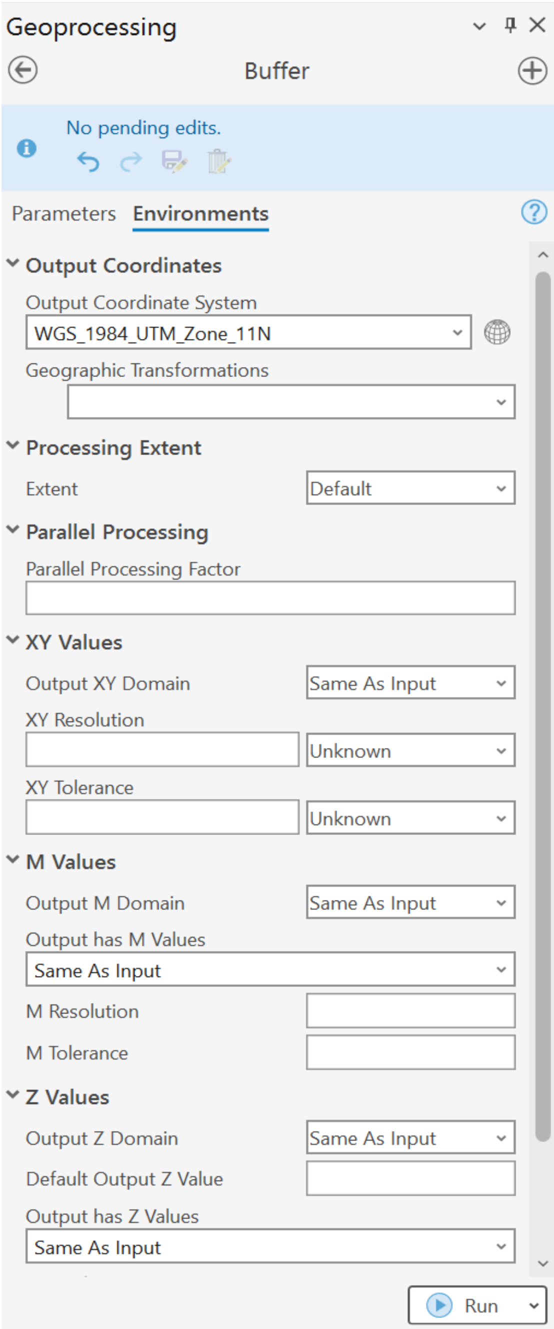
6. Click on ‘View’ and then click on ‘Geoprocessing’ and search for buffer. You will click on the Buffer (Analysis Tools).

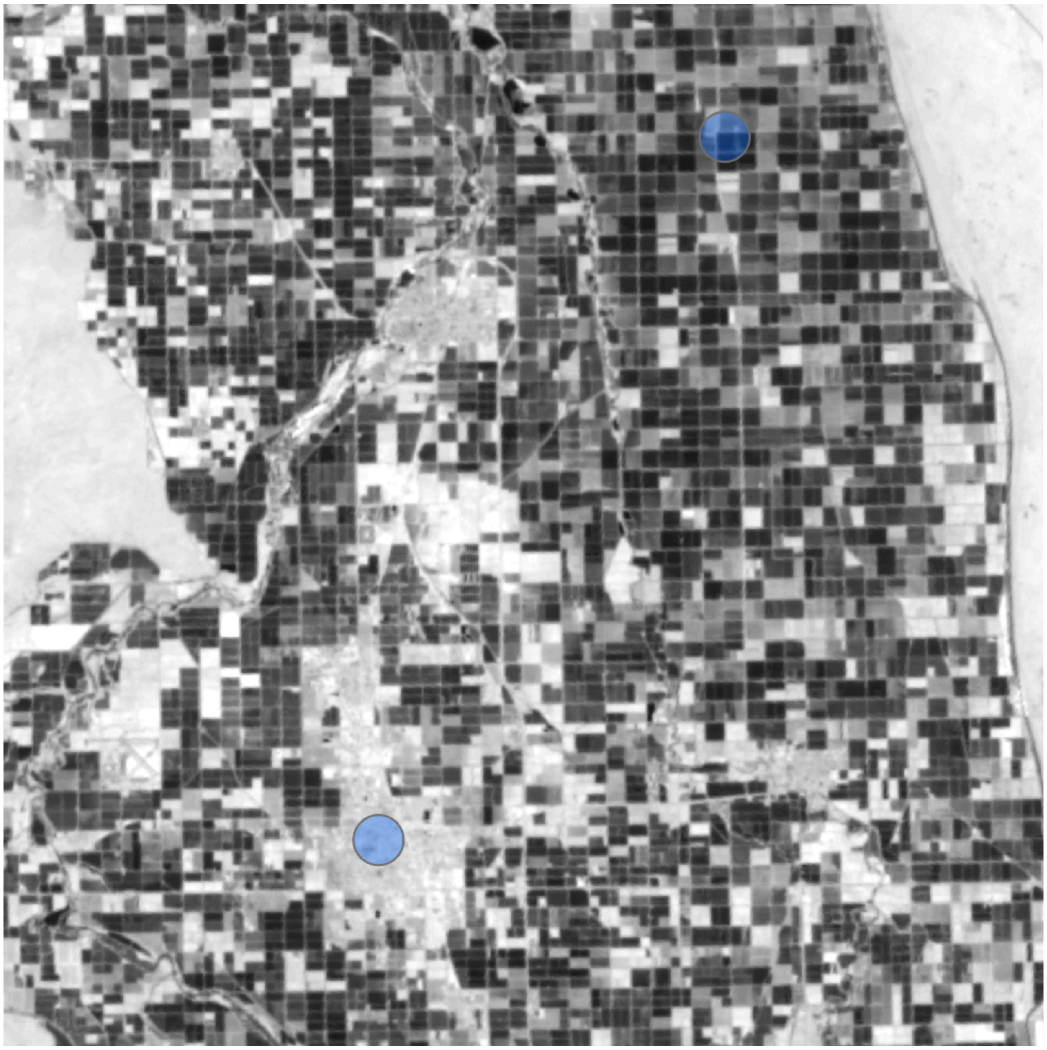


7. On the right-hand side of ‘Input Features’ click on  and select ‘Points’.
8. Hover over your two station points in your map and add the points again. When you are done click 
9. Make sure to name your Output Feature Class as your two station names_buffer (e.g. calipatria_elcentro_buffers).
10. Distance: 1 kilometer
    Method: Planar
    Dissolved Type: No Dissolve



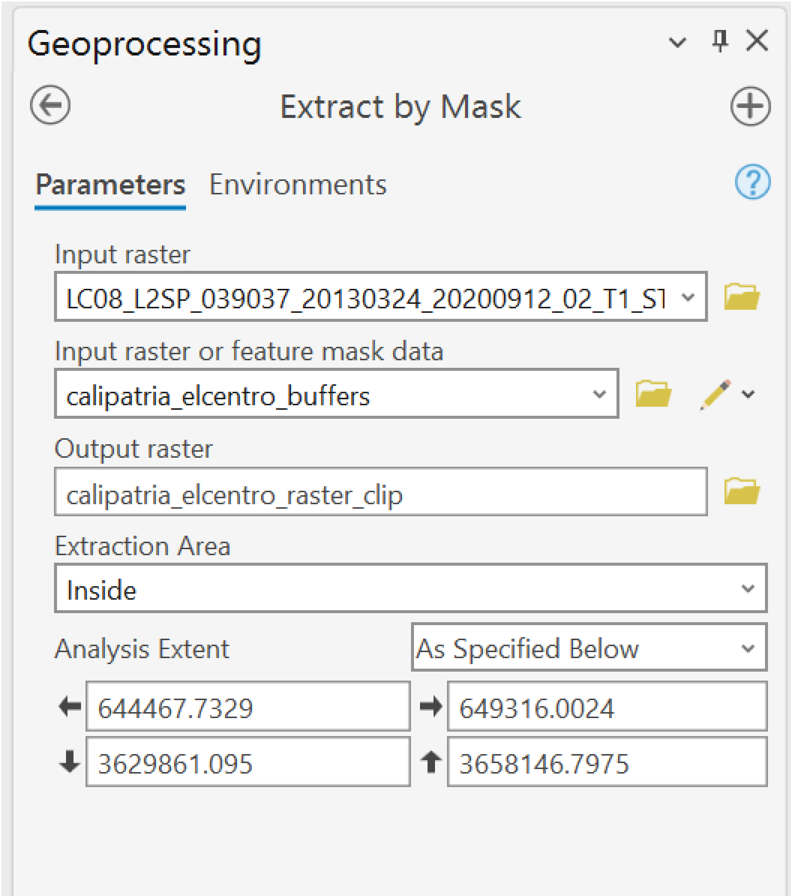
11. Click on Environments. For 'Output Coordinate System' click down and select the raster image. Leave everything else as default and click 'Run'.


Geoprocessing
Buffer
No pending edits.
Parameters
Environments
Output Coordinates
Output Coordinate System
WGS_1984_UTM_Zone_11N
Geographic Transformations
Processing Extent
Extent
Default
Parallel Processing
Parallel Processing Factor
XY Values
Output XY Domain
Same As Input
XY Resolution
Unknown
XY Tolerance
Unknown
M Values
Output M Domain
Same As Input
Output has M Values
Same As Input
M Resolution
M Tolerance
Z Values
Output Z Domain
Same As Input
Default Output Z Value
Output has Z Values
Same As Input
Run

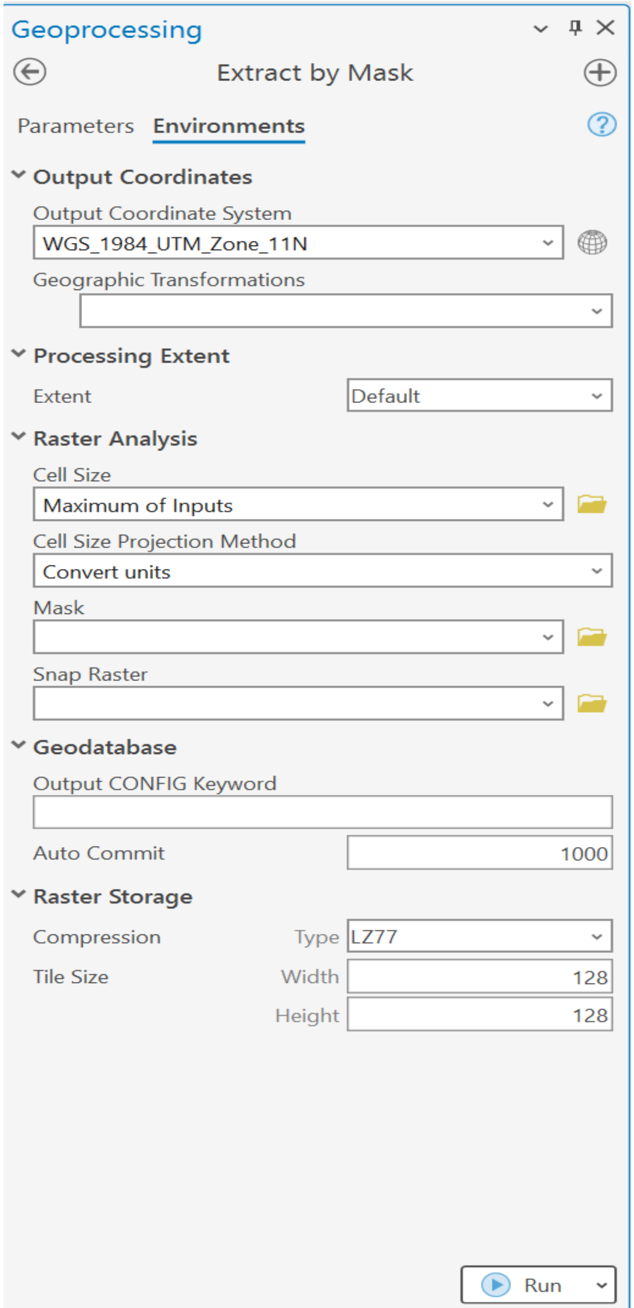


It should look something like this.

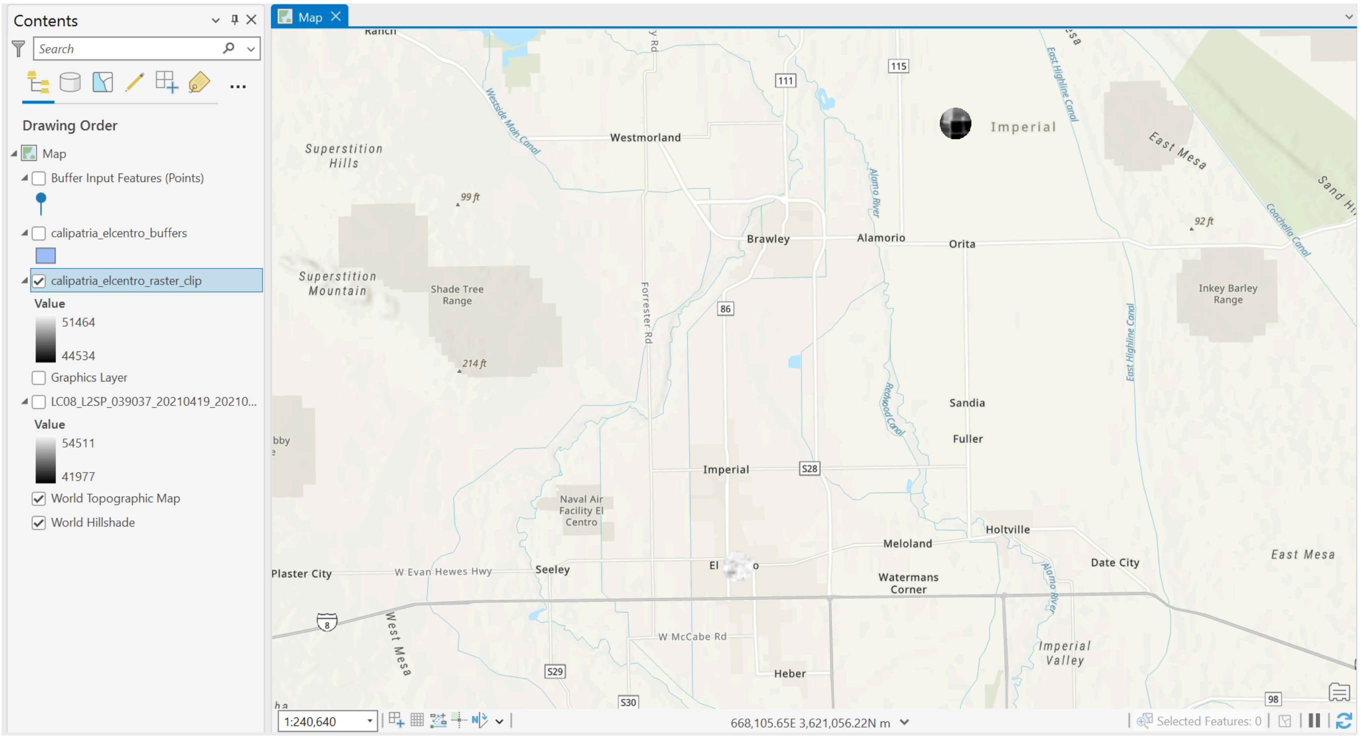
12. Click on 'Geoprocessing' and search 'Extract by Mask'.



13. 'Input raster' will be your Landsat image. 'Input raster or feature mask data' is the buffers you made in step 10 (e.g. calipatria_elcentro_buffers). Output raster Leave everything else as default.
14. Click on Environments. For 'Output Coordinate System' click down and select the raster image. Leave everything else as default and click 'Run'.



15. In your 'contents' window unclick everything besides the clips you just made.



Congrats you just made two buffers for a raster image. Now you need to convert the digital numbers (raw data) to something meaningful aka convert to Land Surface Temperature (LST).

16. Click on 'Geoprocessing' and search 'Raster Calculator'.
17. Use the following equation to convert your values to LST in °C.

Band Designation	Band Name	Data Type	Units	Data Range	Valid Range	Fill Value	Multiplicative Scale Factor	Additive Offset
ProductID_SR_B1	Band 1 SR	UINT16	Reflectance	1 - 65535	7273 - 43636	0	0.0000275	-0.2
ProductID_SR_B2	Band 2 SR	UINT16	Reflectance	1 - 65535	7273 – 43636	0	0.0000275	-0.2
ProductID_SR_B3	Band 3 SR	UINT16	Reflectance	1 - 65535	7273 - 43636	0	0.0000275	-0.2
ProductID_SR_B4	Band 4 SR	UINT16	Reflectance	1 - 65535	7273 - 43636	0	0.0000275	-0.2
ProductID_SR_B5	Band 5 SR	UINT16	Reflectance	1 - 65535	7273 - 43636	0	0.0000275	-0.2
ProductID_SR_B6	Band 6 SR	UINT16	Reflectance	1 - 65535	7273 - 43636	0	0.0000275	-0.2
ProductID_SR_B7	Band 7 SR	UINT16	Reflectance	1 - 65535	7273 - 43636	0	0.0000275	-0.2
ProductID_ST_B10	Band 10 ST	UINT16	Kelvin	1 - 65535	293 - 61440	0	0.00341802	149
ProductID_QA_PIXEL	Level 2 Pixel Quality Band	UINT16	Bit Index	1 - 65535	21824 – 65534	1	NA	NA

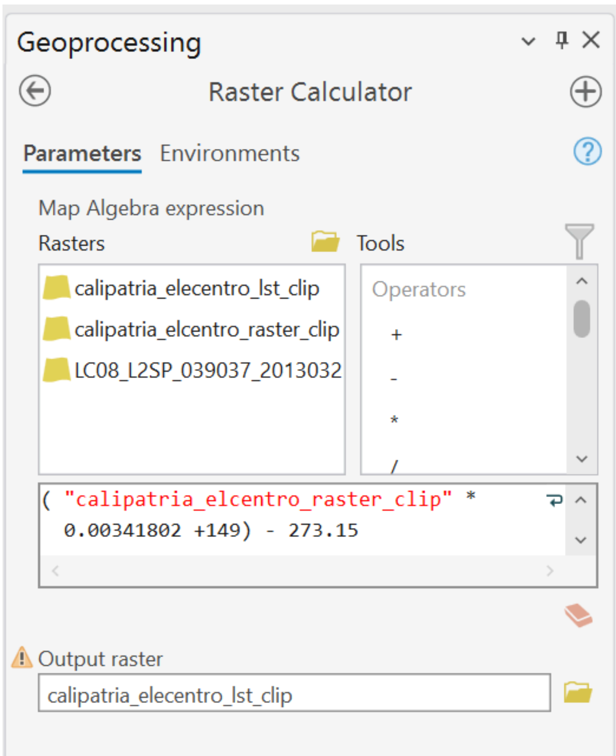
[*Landsat 8-9 Collection 2 Level 2 Science Product Guide | U.S. Geological Survey (usgs.gov)*]

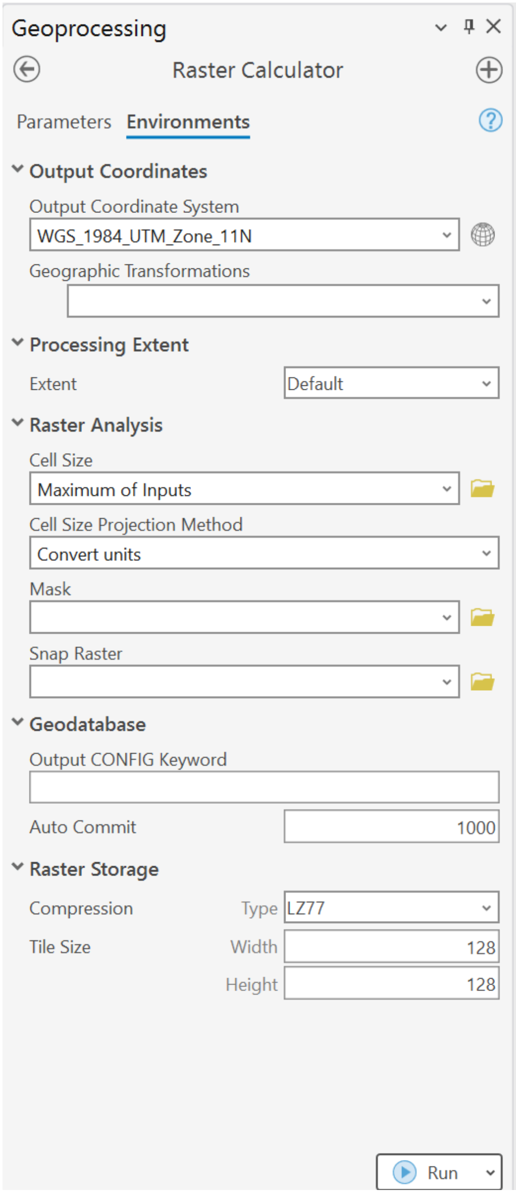
$$LST = (Band\ 10 \times MSF + AO) - 273.15$$

Multiplicative Scale Factor(MSF) = 0.00341802

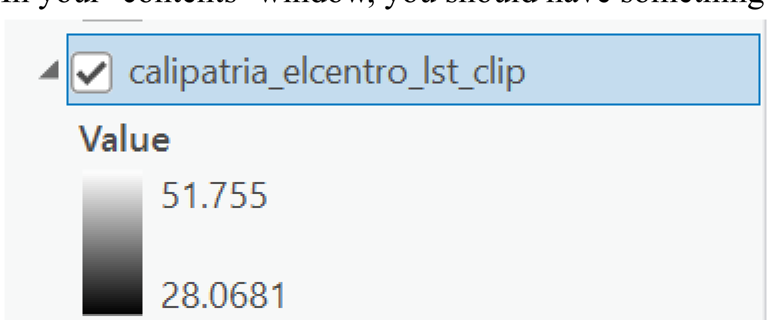
Additive Offset (AO) = 149

Conversion from Kelvin (K) to degree Celsius (°C) = 273.15

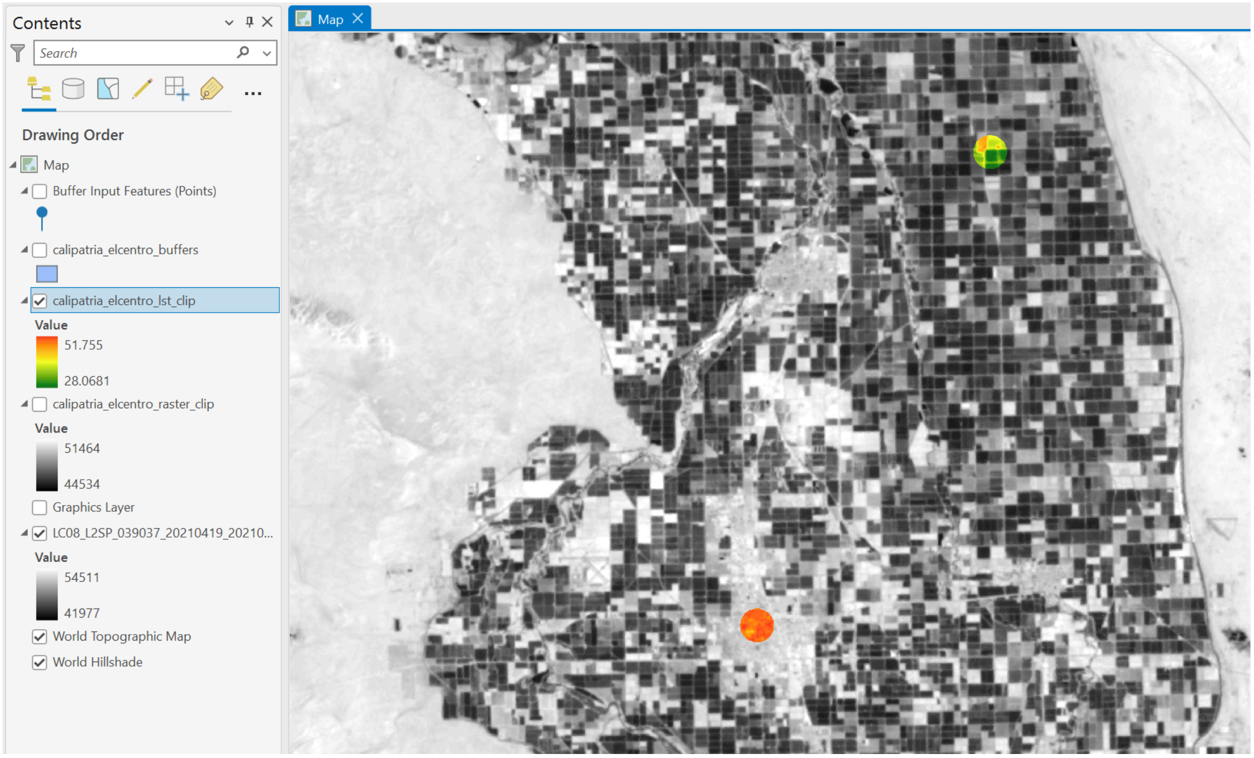




18. In your 'contents' window, you should have something like this.



19. Right-click on the scale bar and change the color scheme



20. Can you guess the land cover within the buffers based on these results?

STOP HERE, BREAK TIME

<u>Step 2: Automation using Python in Google Colab</u>

The key thing here is that there is always more than one way to do something. After graduation, many of us will not have access to ArcGIS Pro, so learning to do these processes in an open-access platform can be very beneficial post-grad school.

I will go over code with the class.

Access code here:
https://colab.research.google.com/drive/1b48Fd0uDAVdXidMHDTWM1g4t887_niFM?usp=sharing

1. Make a copy of the script for your personal use
2. Upload Landsat files (all 3) to Google Colab
3. Make a folder named “landsat_images” and another named “thermal_lab_outputs”
4. Once you run the entire code and get outputs, you can see the CSV file(s) within Google Colab. However, I would suggest downloading the TIF file(s) to view them.

Take breaks, drink water, and good luck on finals! Congrats to those graduating next month!🙂🎉