Exercise 17: Mosaic Datasets and Multidimensional Raster Grids

This exercise was created by Shobha Yadav, PhD student in the Department of Geology and Geography at WVU.

This exercise describes how to work with multidimensional raster data in ArcGIS Pro. Multidimensional raster data can be large and challenging to manage. The primary data management structures for multidimensional raster data are the multidimensional mosaic dataset and the multidimensional Cloud Raster Format (CRF), which is an effective way to store and manage data on which to perform analyses in ArcGIS Pro.

The lab is divided into two sections. In the first section, you will create a mosaic dataset. In the second section, you will work with multidimensional raster data. The data used in the first part of the lab were collected near Kingwood, West Virginia. The data for the second part of the lab were collected from Copernicus, a European agency.

Topics covered in this exercise include:

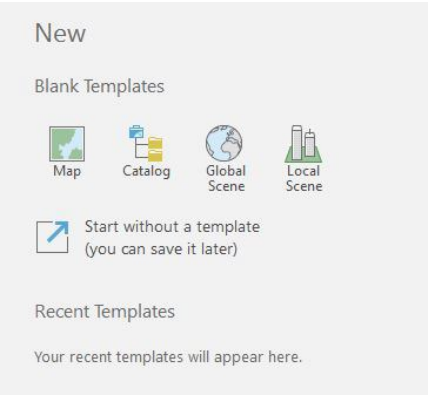
1. Create a mosaic dataset
2. Create a multidimensional raster
3. Analyze and visualize multidimensional raster data

PART I: CREATING MOSAIC DATASETS

Step 1. Create and Prepare a New Project

You will begin the analysis by creating a new project to work within.

- Open ArcGIS Pro. This can be done by navigating to All Apps followed by the ArcGIS Folder. Within the ArcGIS Folder, select ArcGIS Pro. Note that you can also use a Task Bar or Desktop shortcut if they are available on your machine.
- Once ArcGIS Pro launches, select **Map** under New Blank Templates.
- In the Create a New Project Dialog Box, name your new project **Exercise_17** and save it to your personal folder. You can



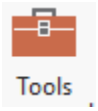
leave the "Create a new folder for this project" option selected.

- Download the **Exercise_17** data from https://www.wvview.org/. All lab materials are available on the course webpage and linked to the exercise. You will need to extract the compressed folder and save it to the location of your choosing.

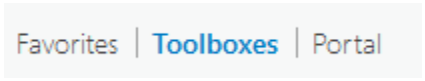
Step 2. Create a mosaic Dataset

All the tools needed to create a mosaic dataset are provided in the **Mosaic Dataset** subtoolbox under **Data Management Tools**. Creating a mosaic dataset can be accomplished using the **Create a Mosaic Dataset** tool.

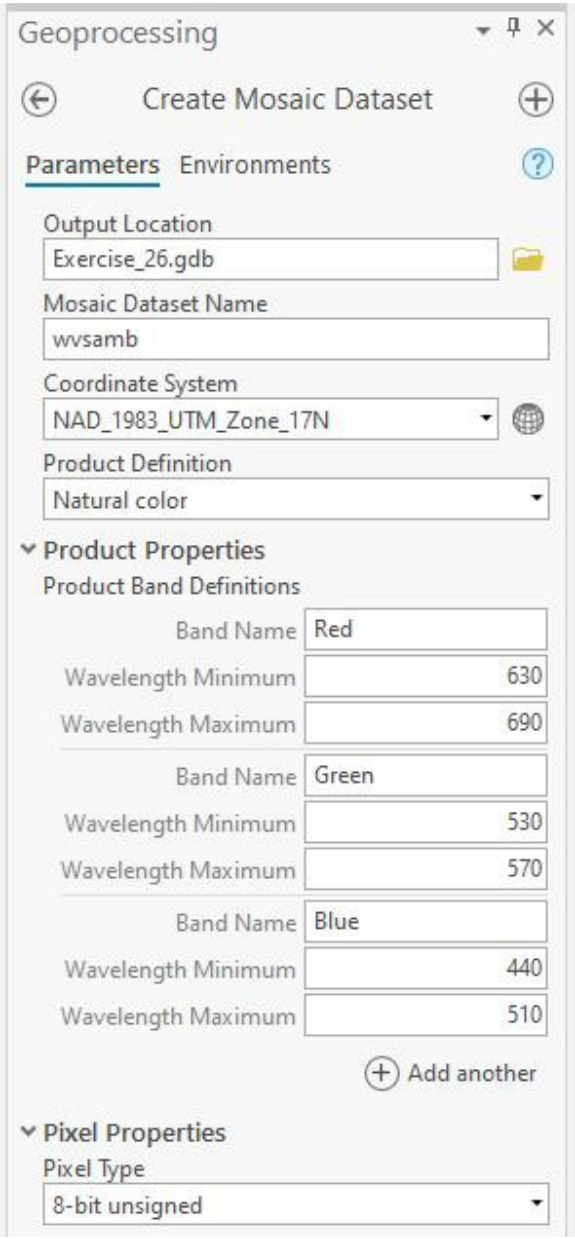
- In the Analysis Tab, select Tools from the Geoprocessing Area. This should open the Geoprocessing Pane.



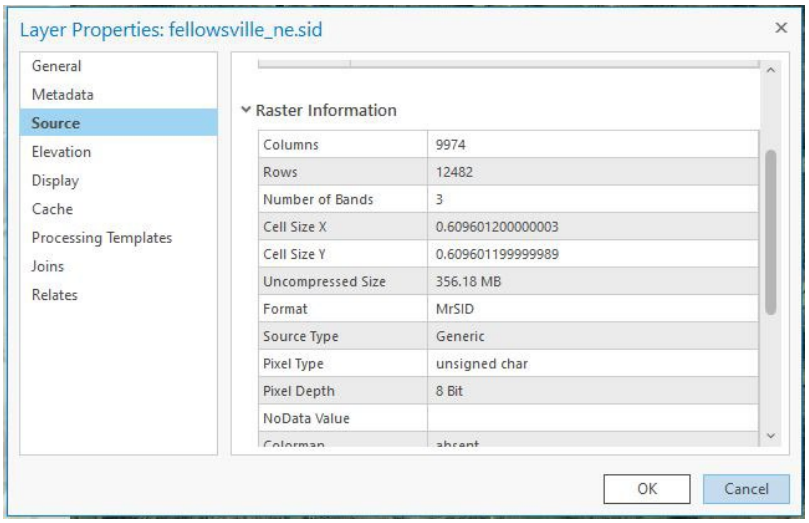
- In the Geoprocessing Pane, navigate to the Toolboxes.



- Navigate to Data Management Tools and then Raster followed by Mosaic Dataset. Click on the **Create Mosaic Dataset Tool**.
- Use the current location of the project as the default output location.
- Name the Output Dataset **wvsamb** and save it to a location of your choosing.
- To use the coordinate system, first, you need to add one image. To do so, navigate to where the downloaded data are located. Click on the "input_images" folder followed by the first folder in the directory. Next, click on the image in this folder. Once the image is added to the map, you should be able to use the coordinate system of the current image.
- Make sure the Coordinate System is set to NAD_1983_UTM_Zone_17N.
- In the Production Definition, use Natural color. The Product Properties will be automatically defined based on Natural Color information.
- Set the Pixel Type to 8-bit unsigned.



- If you are not aware of the pixel properties of the raster image, you can find them under the properties for the raster file. Right-click on the image in the Contents Pane. Go to Source and click on Raster Information as shown in the image below.



- After all the parameters are defined, click Run to execute the tool.
- It will take a few seconds to run the tool. Once it is done, your output will automatically be added to the Contents Pane.

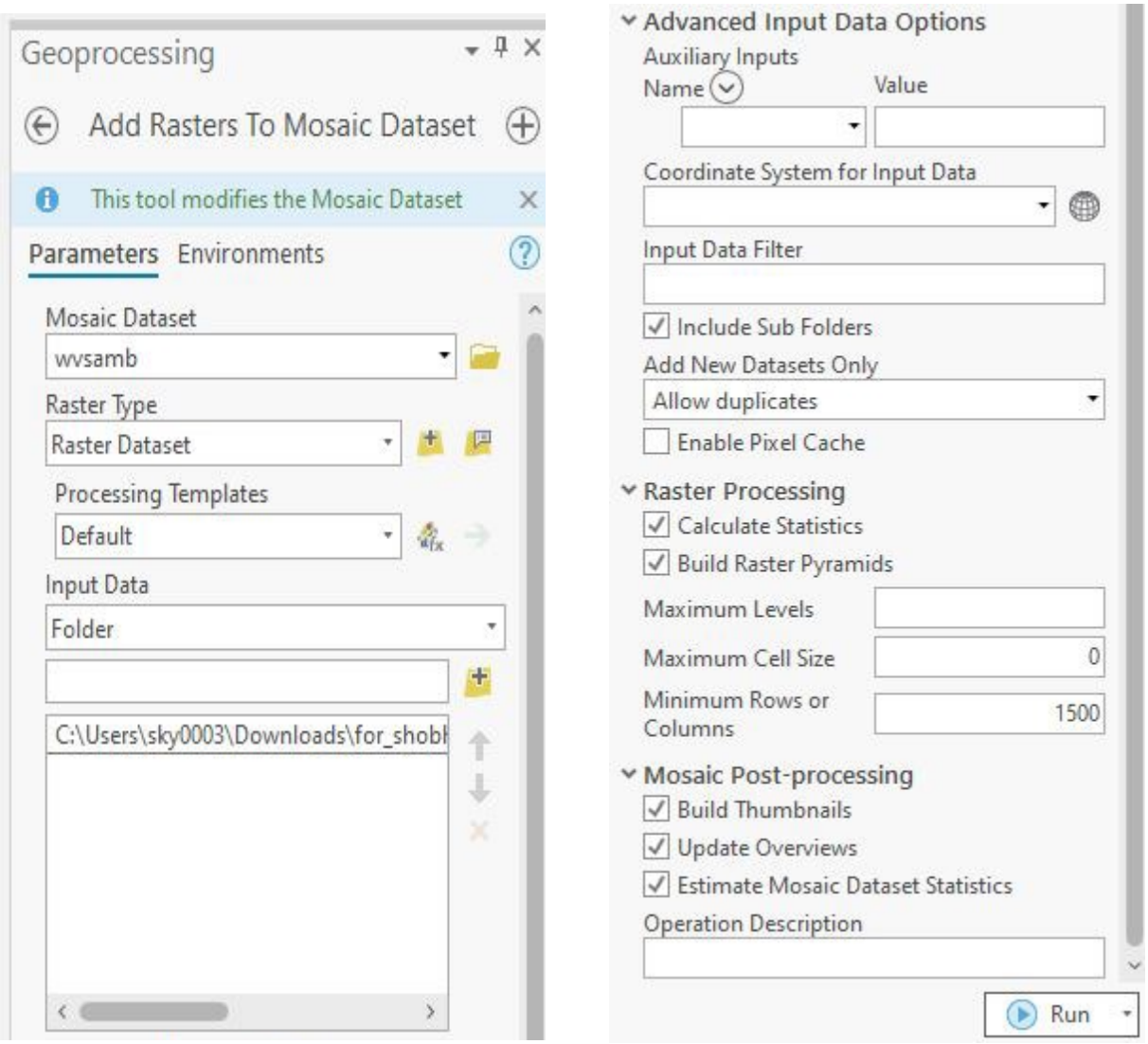
Question 1. What is the cell size of wvsamb? (2 Points)

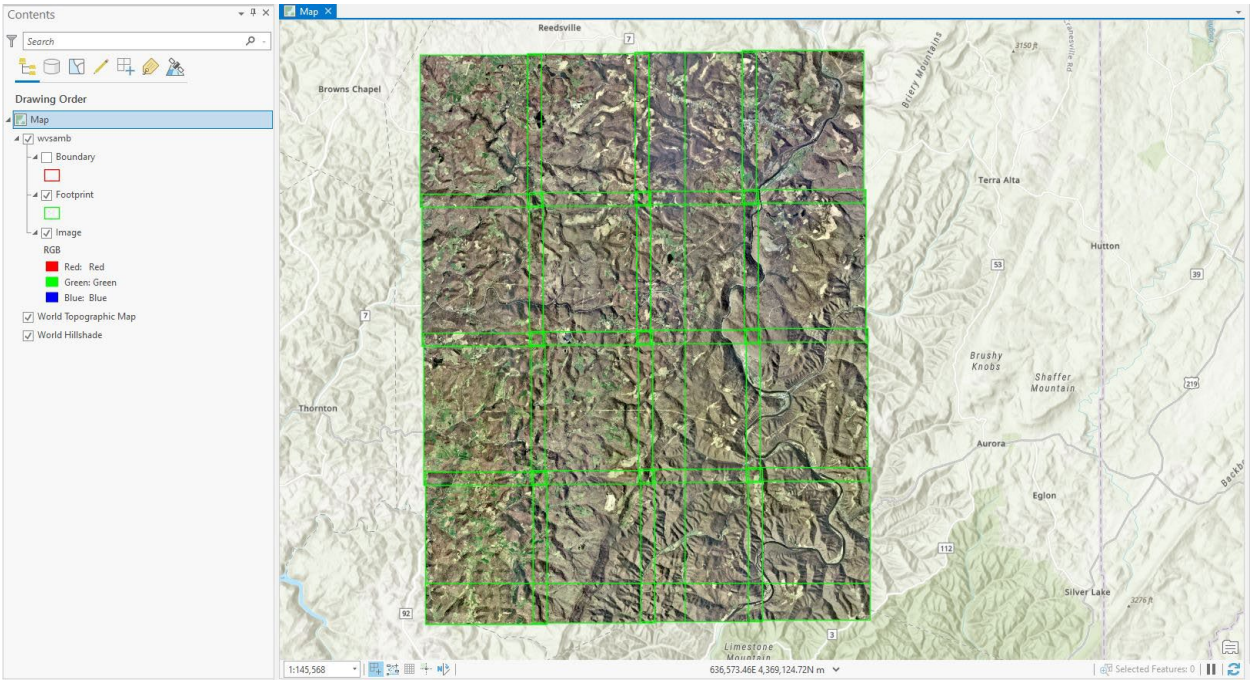
Step 3. Add data to the mosaic dataset

You will now add data to the mosaic dataset you just created.

- To do so, you need to navigate to **Data Management Tools** → **Raster** → **Mosaic Dataset**. Click on the **Add Rasters To Mosaic Dataset** tool.
- In the new window, use the previously created mosaic dataset, **wvsamb**, as the input for Mosaic Dataset.
- Leave the Raster Type to Raster Dataset and Processing Templates to Default.
- Make sure that Input Data is set to Folder instead of the File.
- Click on the plus button and navigate to the folder where your data are stored.
- From Advanced Input Data Options, check on the "Include Sub Folders" option.
- Click on Calculate Statistics and Build Raster Pyramids under Raster Processing. Leave the Maximum Cell Size and Minimum Rows or Columns as default.
- Select Build Thumbnails, Update Overviews, and Estimate Mosaic Dataset Statistics under Mosaic Post-Processing.

- Click Run to execute the tool. This may take several minutes.
- Once the tool execution is complete, your mosaic dataset created earlier will be updated.
- The map will look like the image below.





- This ends the first part of this lab.

Note: You can convert a multidimensional mosaic dataset to a CRF dataset. To do so, use the Copy Raster tool, choose. crf as the output format, and check the "Process as a multidimensional raster" option. You can use these data for multidimensional raster data analysis.

Question 2. Explain the difference between a raster grid and a raster mosaic dataset? (4 Points)

Question 3. Why might you choose to use a raster mosaic dataset as opposed to merging multiple raster files into a new raster grid? (4 Points)

PART II: WORKING WITH MULTIDIMENSIONAL RASTER

You will now work with multidimensional raster data. Multidimensional data store values in multiple dimensions. For example, two dimensions could be used to represent coordinates (x and y or longitude and latitude), one could represent altitude, one could represent time, and another could represent the variable of interest. This is in contrast to a traditional raster grid, which can have no more than three dimensions: rows, columns, and channels. Multidimensional raster data are often used in oceanography, climate

analysis, and agriculture. ArcGIS Pro provides a set of tools for analyzing, visualizing, and sharing multidimensional raster data. For more information, check out the help documentation associated with multidimensional analysis.

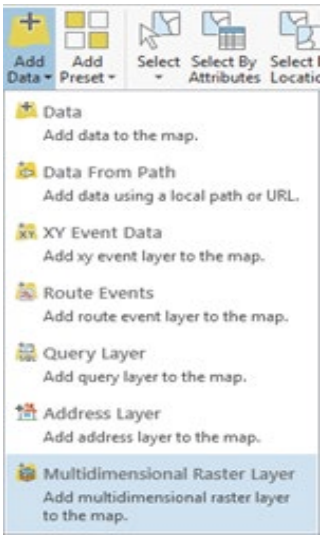
To work with multidimensional raster data in ArcGIS Pro, the data are generally first converted to Cloud Raster Format (CRF). CRF is an ESRI-created raster format optimized for writing and reading large files in a distributed processing and storage environment. CRF supports multidimensional data, making it faster and more efficient to access large chunks of information from a large volume of raster data.

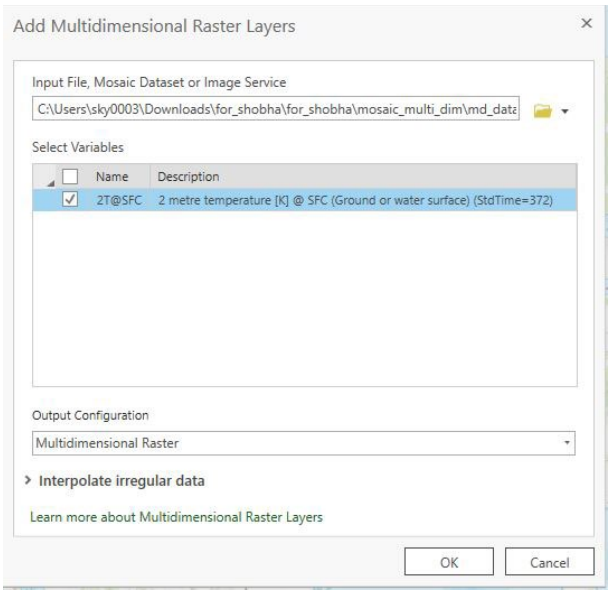
In this lab, you will be using 2-meter temperature data of the Tibetan Plateau from 1990 to 2020. The data were downloaded from the European Reanalysis Data Center of Copernicus. They were downloaded in NetCDF format and later converted to CRF format.

Step 1. Add multidimensional raster

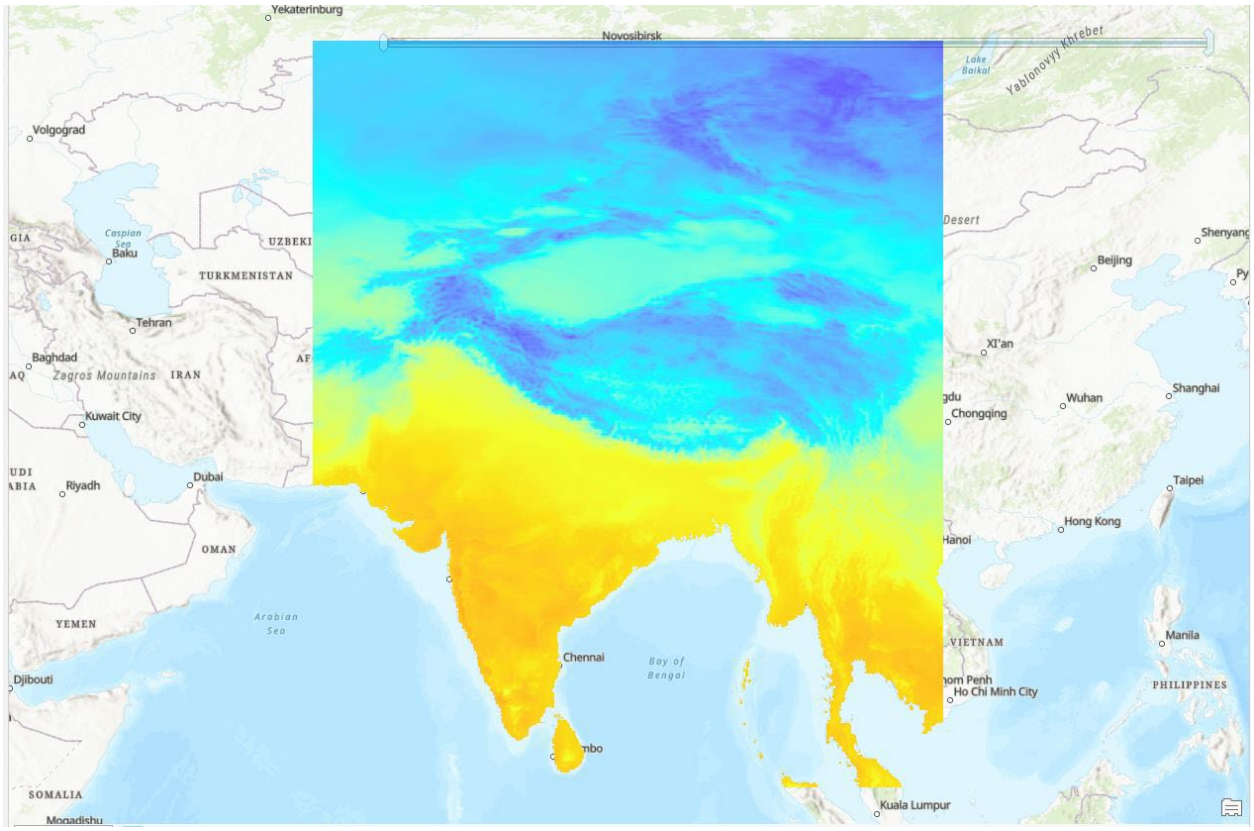
To add the multidimensional raster data, first, you need to insert a new map into the project.

- Click on New Map under the Insert ribbon.
- To add multidimensional raster data, click on the small triangle on Add Data under the Map ribbon. From the drop-down list, click on the Multidimensional Raster Layer option.
- Navigate to the folder where your copy of the data was downloaded and stored. Click on **md_data2.crf**.
- A new window will appear.
- In the new window, check the box next to 2T@SFC.
- Click OK, and the data will be added to the Map.





- The map will look something like this.

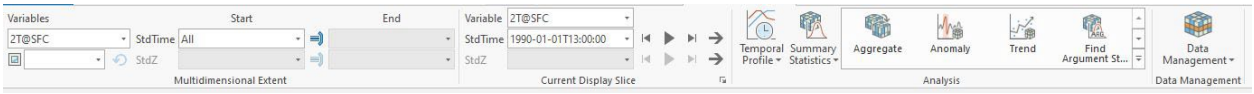


Question 4. Explain the pattern of temperature in this extent. (4 Points)

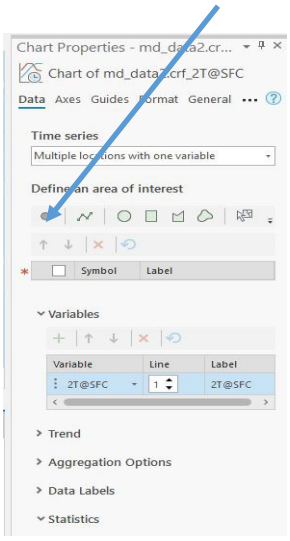
Step 2. Explore the Data

Next, you are going to explore the data. To do so, click on the layer in the Contents Pane, and you will see the play button appear on the map. Click Play, and you will see the seasonal variation of 2 m temperature data over the Tibetan Plateau.

- Before exploring the data, you will need to add the boundary of the Tibetan Plateau.
- Navigate to Map and click on Add Data. Add the shapefile of the plateau that was provided in the lab data folder to the map.
- If you click on the multidimensional layer in the Contents Pane, a Multidimensional Tab will appear on the ribbon. This tab provides tools applicable to multidimensional data. For instance, you can select several variables, if multiple variables are available, under the Variable tab. Similarly, you can choose a time frame for analysis by specifying it using Start and End dates.



- Now, click on **Temporal Profile**.
- Under the chart properties windows, use the point selection option to select the location of interest and click on any area where you would like to explore the 2 m temperature time series. You can also use a circle, rectangle, or polygon to define your area of interest. For this lab, you will use points to extract time series data for a couple of points.
- Click anywhere in the western and eastern sections of the Tibetan Plateau. You will see a time series graph of temperatures appear below the map. Take a moment to explore the difference between 2 m temperature between two locations.
- Also, make sure you check the statistics of both locations.



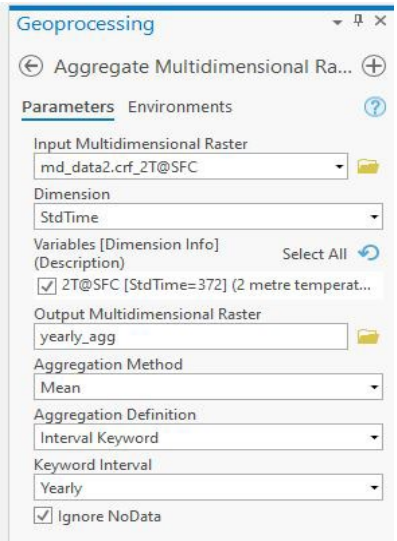
Question 5. Explain the temperature pattern between two locations. Does it appear as if there are differences between the eastern and western plateau? (4 Points)

Question 6. What was the mean and maximum temperature recorded for each station? (4 Points)

Step 3. Aggregation

You will now aggregate the monthly temperature data to yearly temperature data.

- Navigate to the **Aggregate Tool** and click it.
- In the new geoprocessing window, name the Output Raster **yearly_agg** and save it to a location of your choosing.
- Use the **Mean** for the Aggregation method.
- Use **Interval Keywords** under Aggregation Definition.
- In the Keyword Interval, use Yearly.
- Maintain the default settings for all other options.
- Click Run to execute the tool.

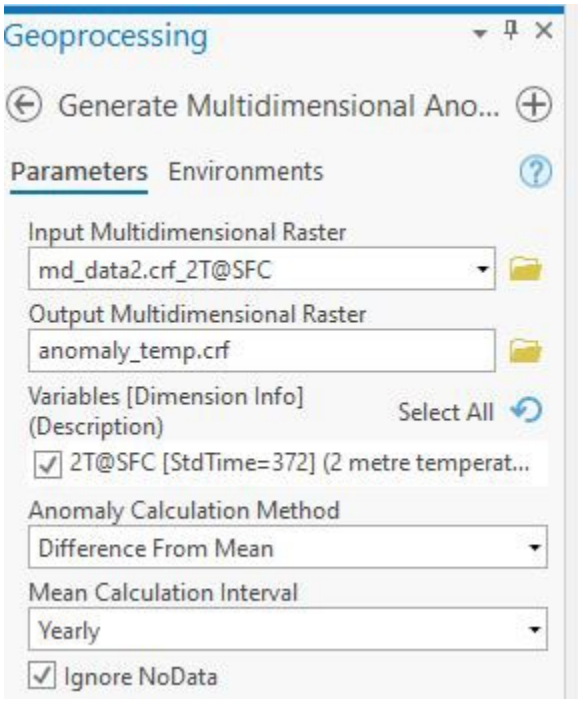


Question 7. Provide a screen capture of your yearly aggregated data. (4 Points)

Step 4. Anomaly Analysis

In this last step, you will analyze for anomalies in 2 m mean temperature from 1990 to 2020. An anomaly is an abnormality in the data series, generally defined based on deviation from the series mean.

- Click on the **Anomaly Tool** in the Multidimensional tab.
- Set the Input Multidimensional Raster to the **md_data2.crf** layer.
- Name the Output Raster **anomaly_temp** and save it to a location of your choosing.
- Make sure the Anomaly Calculation method is set to Difference from the Mean.
- Make sure the Mean Calculation Interval is set to yearly.
- Click Run to execute the tool.



After the run has executed, it will add a new layer in the Contents Pane.

- Right-click on the **anomaly_temp** layer in the Contents Pane. Go to Create Chart and click on the **Temporal Profile**.
- Repeat the process outlined in Step 2 to generate a time series from the yearly anomaly data at two locations, one in the western Tibetan Plateau and one in the eastern Tibetan Plateau.

Question 8. Explain the anomaly patterns between two locations. Does is appear as if there are differences between the eastern and western plateau? (4 Points)

Question 9. Provide screen captures of the temporal profile graph for the two locations. (4 Points)

END OF EXERCISE