

# GeoEarthScope “NoCAL” San Andreas System LiDAR pre computed DEM tutorial

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## Overview

This simple data and ArcGIS demonstration will illustrate:

- The spatial distribution of GeoEarthScope LiDAR data imaging the northern San Andreas Fault that was recently delivered from the National Center for Airborne Laser Mapping (NCALM)
- The data types and formats that are currently available as GeoEarthScope LiDAR data
- How to display and manipulate the data in ArcMap and ArcScene.

## Data set overview

The GeoEarthScope Northern California LiDAR project acquired high resolution airborne laser swath mapping imagery along major active faults as part of the EarthScope Facility project funded by the National Science Foundation (NSF). Between this project and the previously conducted B4 project, also funded by NSF, the entire San Andreas fault system has now been imaged with high resolution airborne LiDAR, along with many other important geologic features. EarthScope is funded by NSF and conducted in partnership with the USGS and NASA. GeoEarthScope is a component of EarthScope that includes the acquisition of aerial and satellite imagery and geochronology. GeoEarthScope is managed at UNAVCO.

## Data delivery scheme

We are receiving the data as its processing completes from the UC Berkeley arm of NCALM. In this demonstration, we will play with the filtered and unfiltered 1km x 1km ArcInfo grids @ 0.5m cell size and their shaded relief maps (NO overlap).

Due to ArcInfo file naming limitations, the grids contain only the significant digits from the lower left coordinate of their originating tile. For example, the ASCII tile named “f571000\_4130000.xyz” corresponds to the ArcInfo elevation grid named “fg571\_4130” and shaded relief map “fg571\_4130shd”. Filtered elevation grids are prefixed by “fg” and the hillshades end in “shd”. Unfiltered elevation grids are prefixed by “ug” and the hillshades end in “shd”

*For all these data the projection is UTM Zone 10N, WGS84 ellipsoid heights.*

## Data access

We assume that you know how to get into the Geon LiDAR Workflow pages inside the GEON Portal:

<http://www.geongrid.org> -> “Enter the GEON Portal” -> Login (as guest, or register) -> Tools tab -> LiDAR.

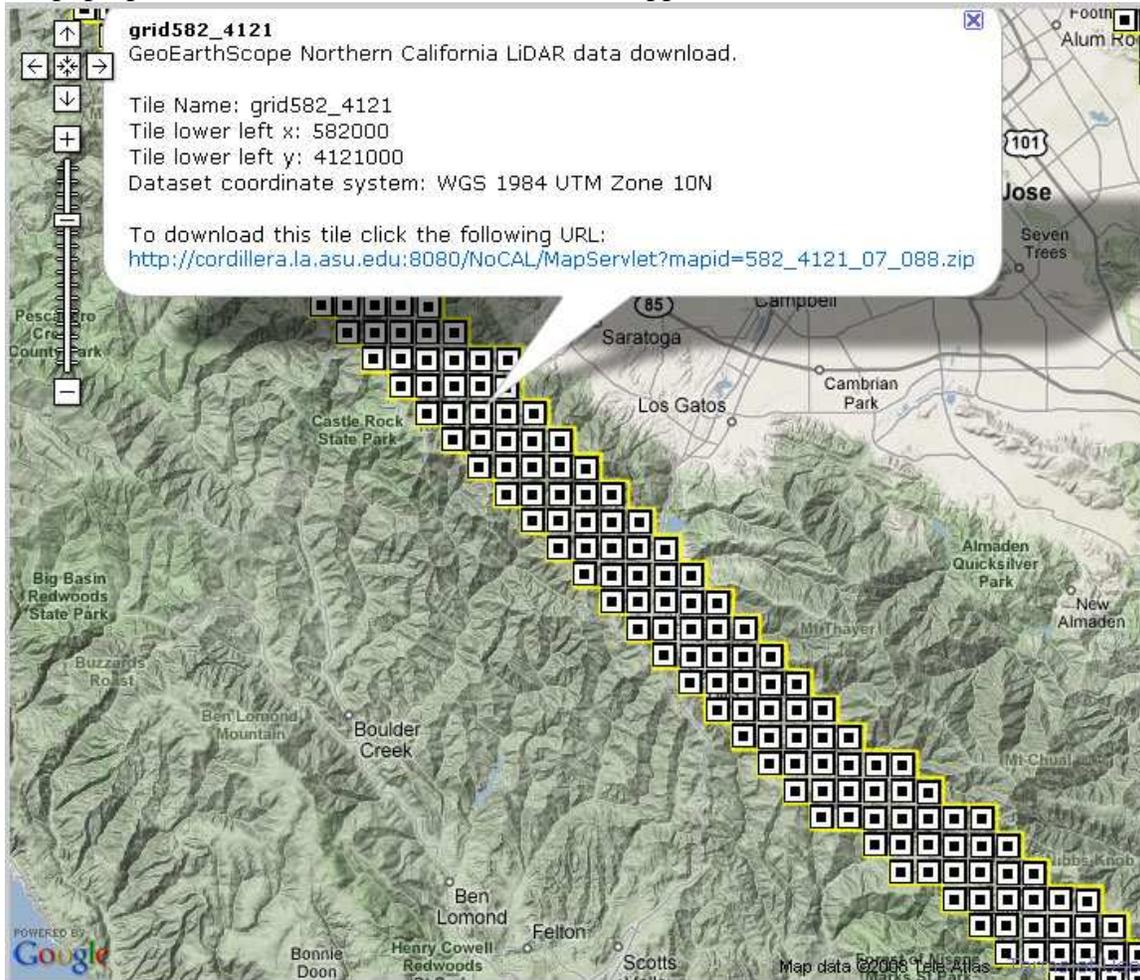
Click on the GeoEarthScope Northern California LiDAR Project (NoCAL) link.

The screenshot shows the GEON Portal interface in a Mozilla Firefox browser. The page title is "Lidar Application". The main heading is "LiDAR / ALSM Data Processing with GEON Cyberinfrastructure". Below the heading is a welcome message and a "Lidar Status Updates" section indicating "LIDAR System Status Normal". A section titled "Please select a data set:" lists several data sets with question mark icons: "Northern San Andreas Fault (NSAF), CA", "West Rainier Seismic Zone, WA", "Fault systems in the Eastern California Shear Zone (ECSZ)", "B4: Southern San Andreas Fault", and "GeoEarthScope Northern California LiDAR Project (NoCAL)". An arrow points to the "GeoEarthScope Northern California LiDAR Project (NoCAL)" link. The sidebar on the left contains "Lidar Datasets" (NSAF, Mt. Rainier, ECSZ, B4, NoCAL GeoEarthScope) and "LIDAR Utilities" (My LIDAR Jobs, My Jobs Submission Info, GEON LIDAR Forum, GLW Users Guide (pdf)).

The interactive map shown below permits users to download 1 km<sup>2</sup> filtered ("bare earth," fg\*) and unfiltered (ug\*) 0.5 m resolution digital elevation models in Arc Binary grid format. The dataset extent is shown on the map as yellow polygons. There is a download "button" for each 1 km<sup>2</sup> tile in the dataset. You will need to zoom into the area of interest to see all of the buttons. To navigate, use the standard GoogleMaps + to zoom in, - to zoom out, the arrows to pan, or just grab the image to pan.

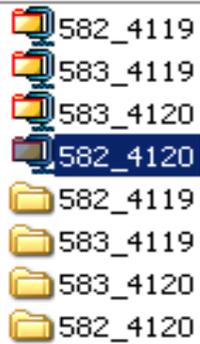


Zoom in to the area of interest. When you are getting close, the center points of the tiles will appear. To download a DEM click the button and then select the link that appears in the pop-up window. The DEMs are delivered in zipped archives for download.



\*Note that in places, a second set of tiles may be available for a given location (the area was flown twice). They will have a flight number appended to their name (583\_4120\_07\_088.zip).

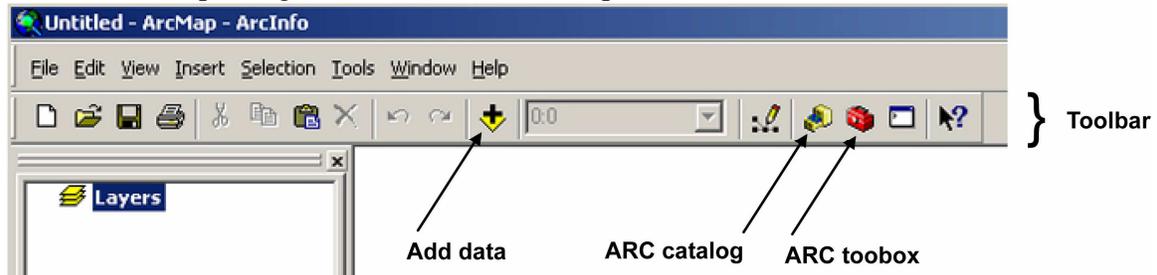
In this demo, download and unzip 4 adjacent tiles.



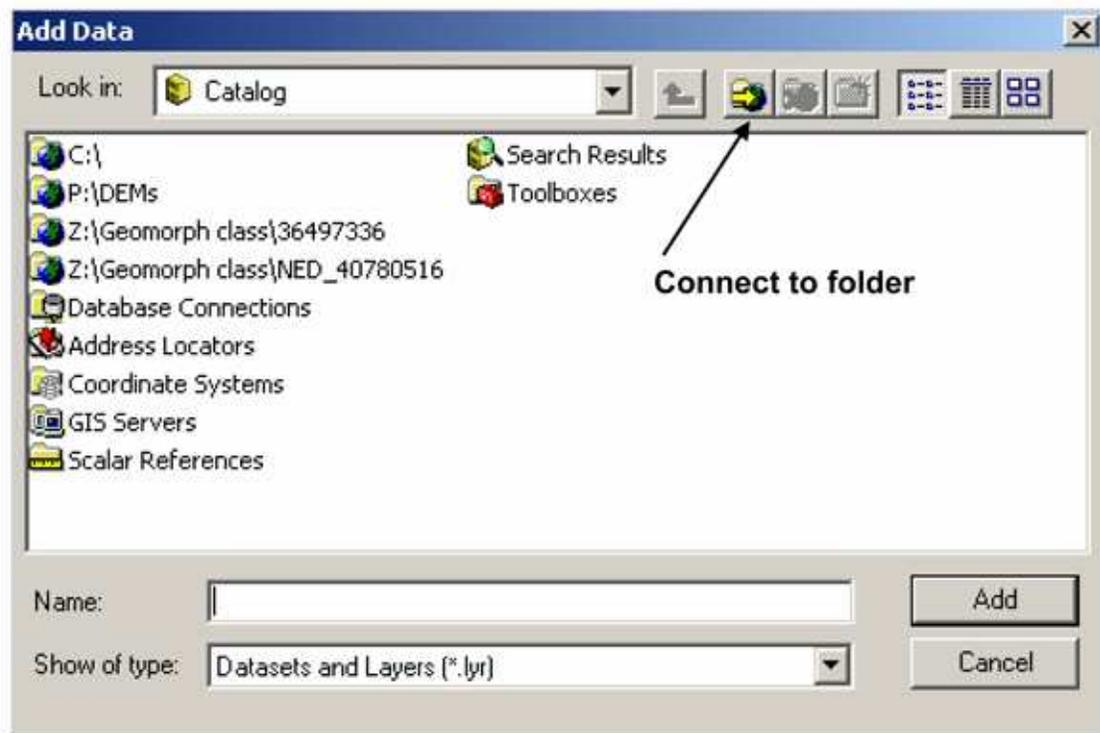
## Simple data processing in ArcMap

### *Loading the files*

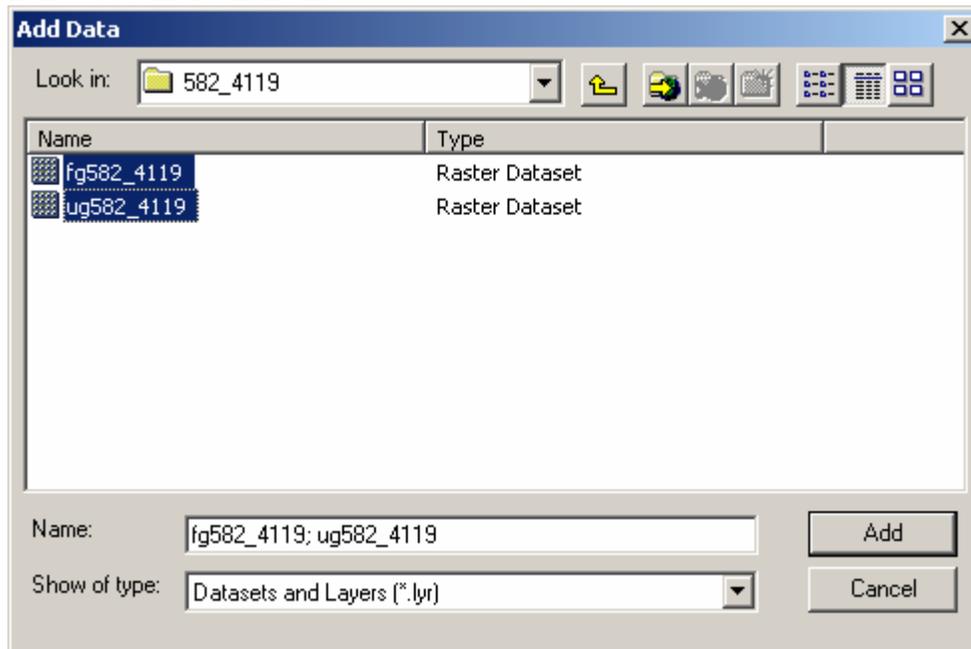
Launch ArcMap (Programs->ArcGIS->ArcMap)



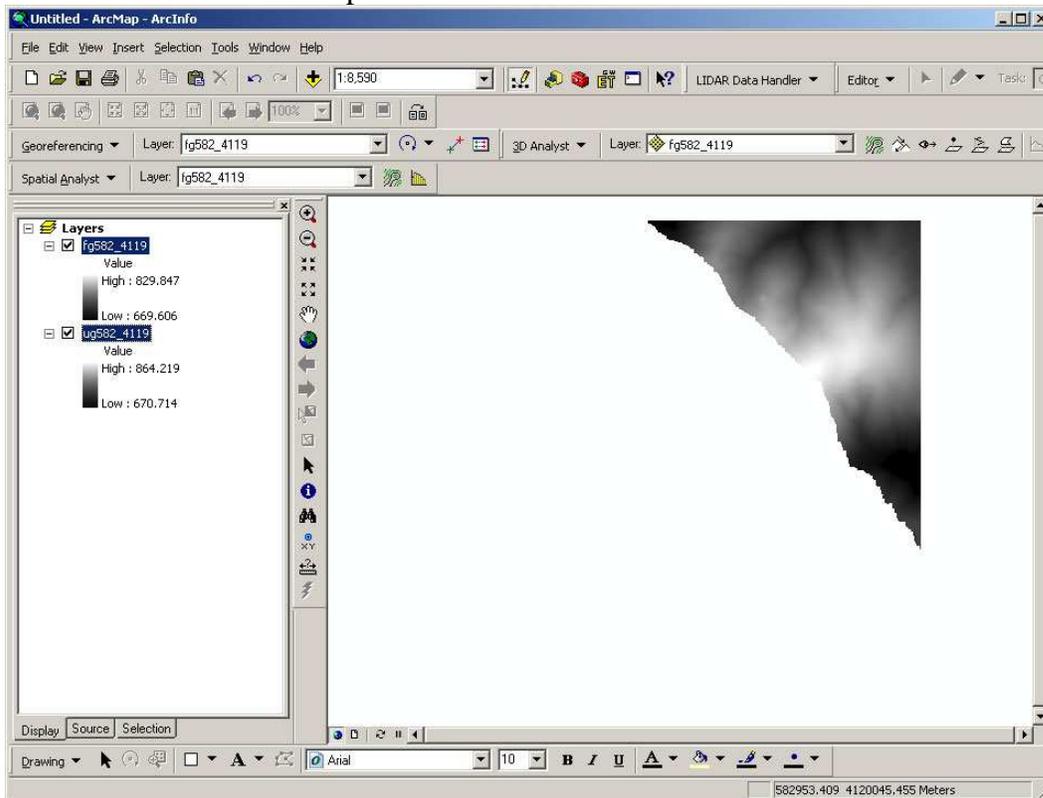
Push the **Add data** button and the following window will open. Use the **Connect to folder** button to browse to the location where you saved the (unzipped) data. When you press OK, you will see the folder that contains the DEM file in the 'Add data' window. Double-click it, select the file and add it.



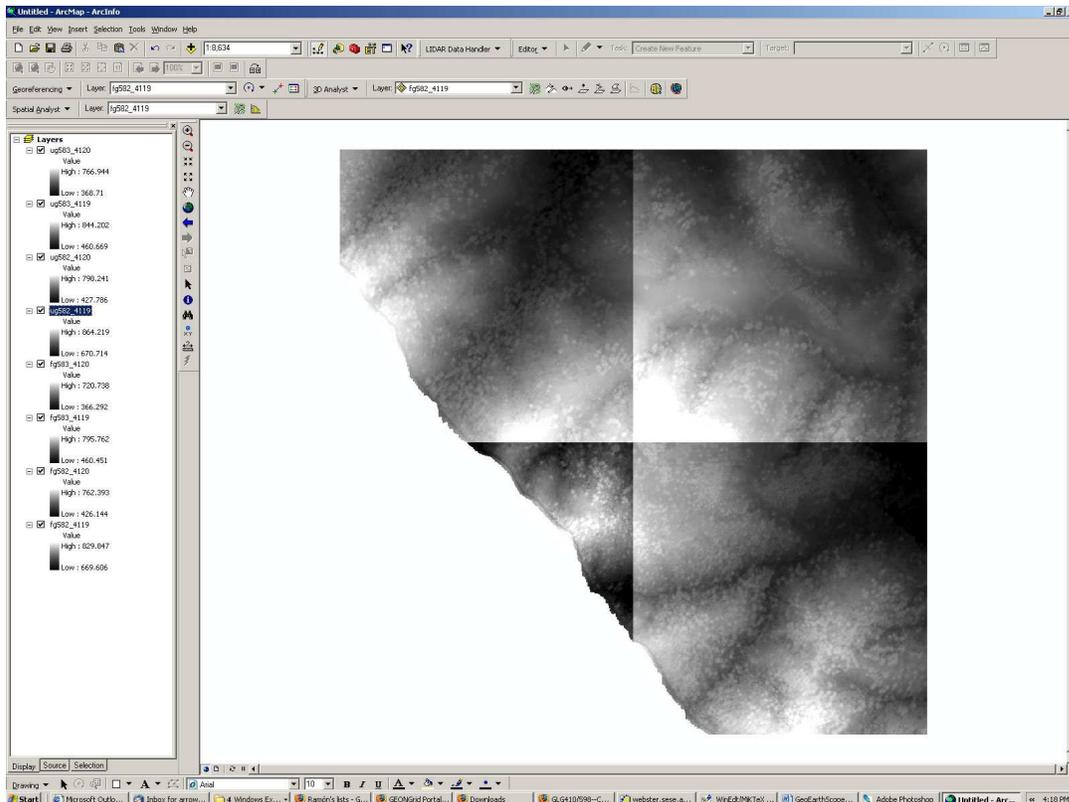
Shift click to add more than one:



And the DEM is in ArcMap!

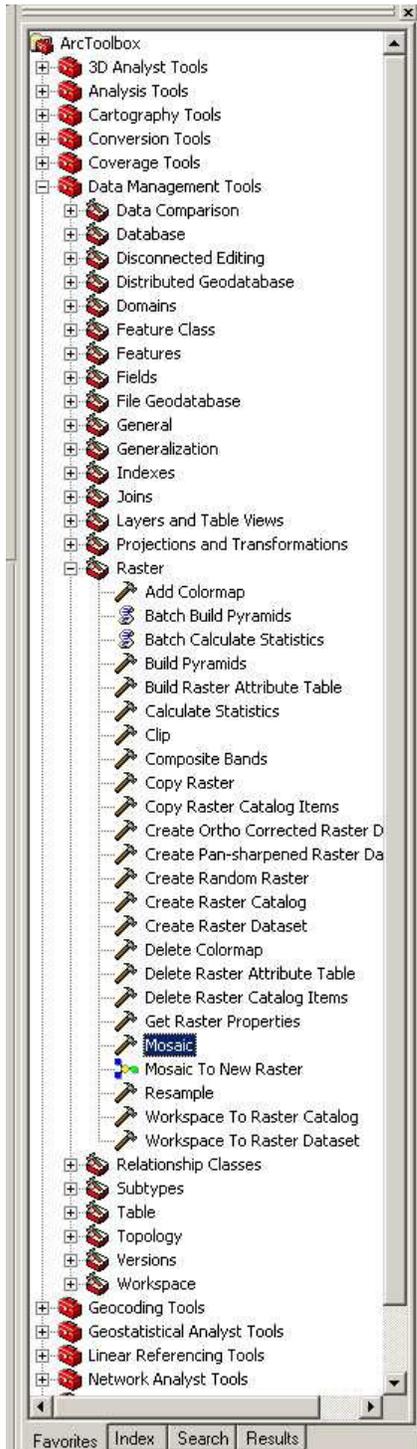


Load the rest and move them up and down the left window so that all of the unfiltered are above all of the filtered.

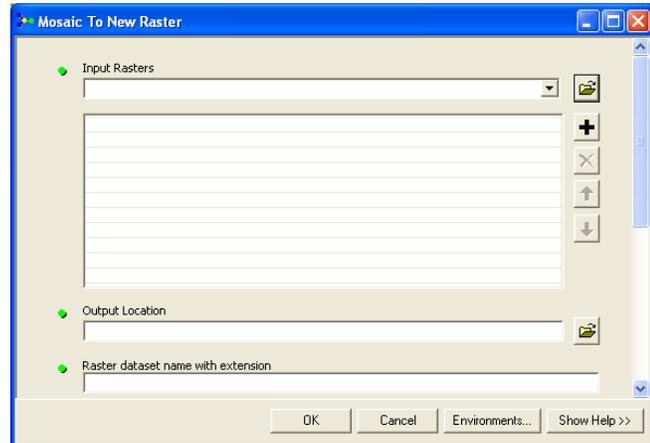


## Mosaicking the files

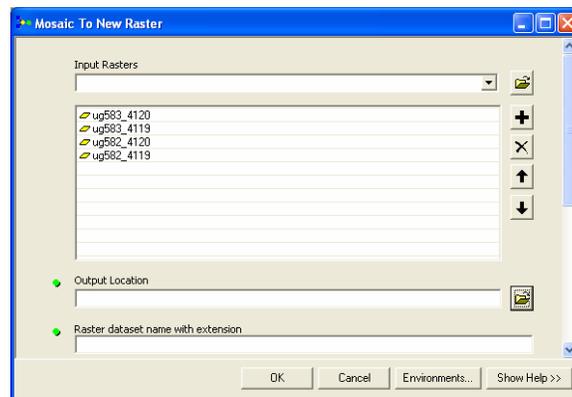
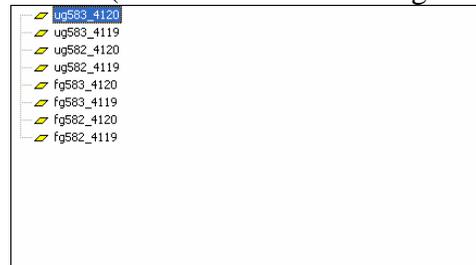
You do not have to do this, but it makes things generally more convenient. Just be careful that the more tiles that you mosaic, the bigger the result will become. The mosaicking tool is accessible in the ArcToolbox. Click on the little red box on the toolbar, and then on the little +s in front of Data Management Tools->Raster->Mosaic To New Raster.



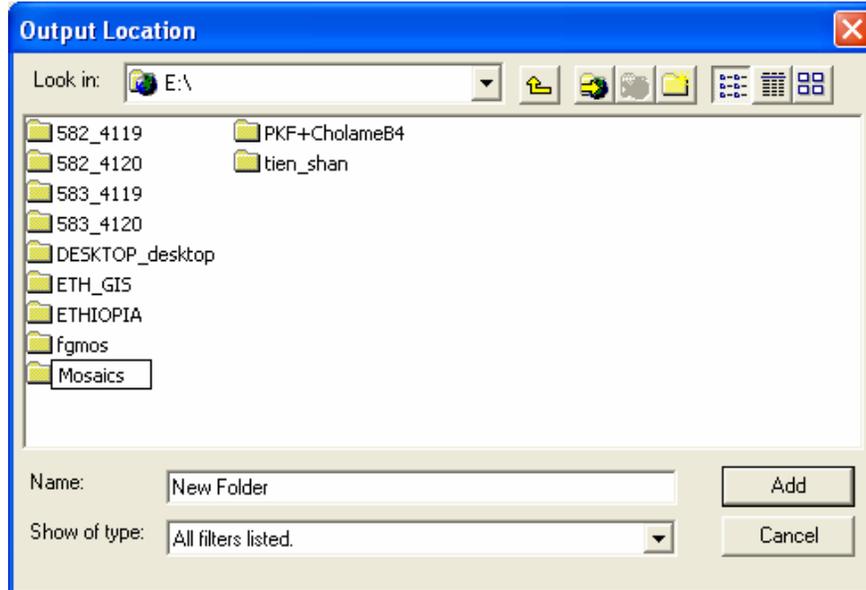
Double click on Mosaic To New Raster.



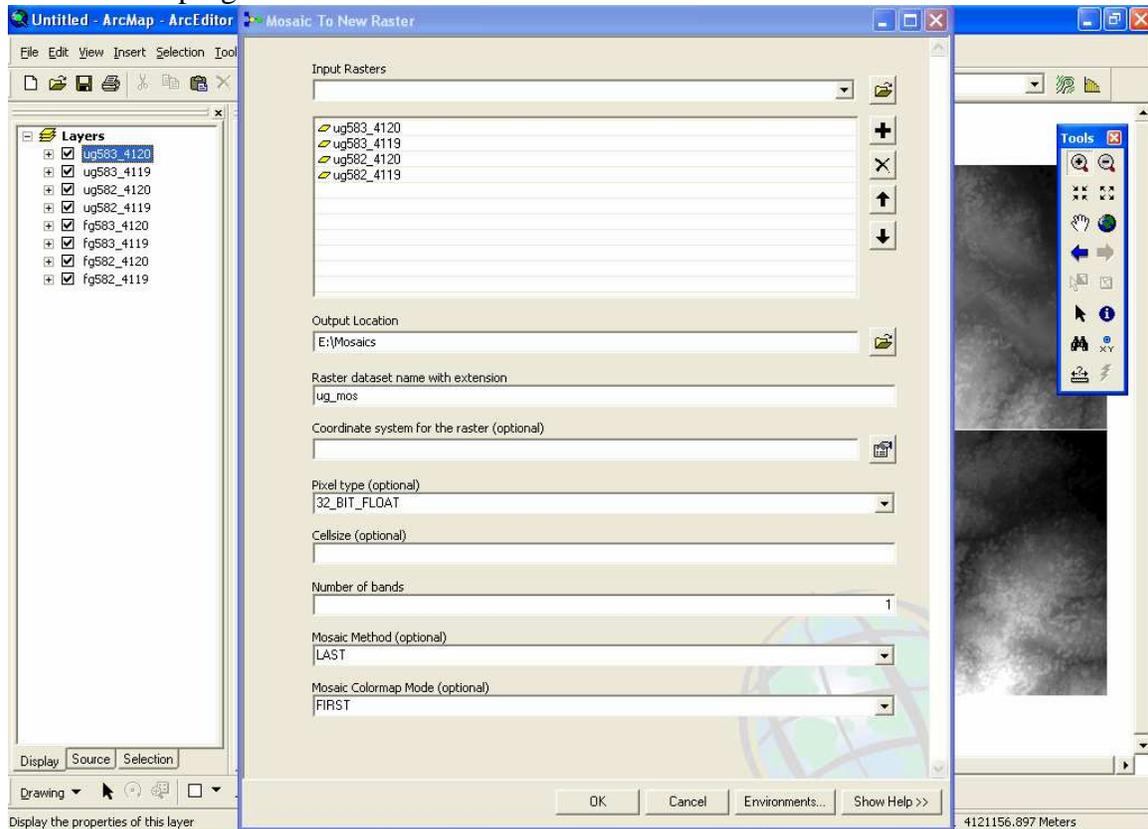
Click on the downward pointing triangle and highlight one at a time the files you want to mosaic (all of the unfiltered—ug\* for now).



After the files are identified, then click on output location and make a new directory (in this case MosaiCs), and then click Add.

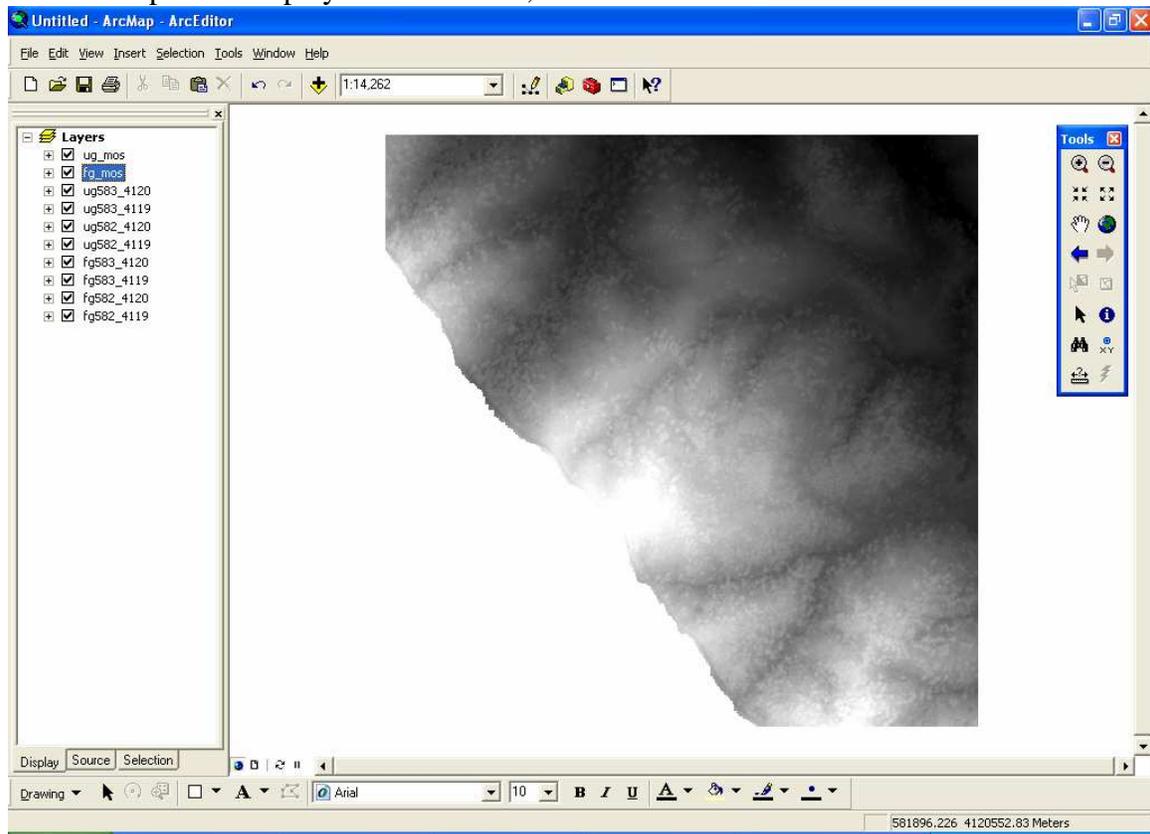


Name the resulting mosaic (make sure that the filename is less than 13 characters long).. Make sure that the Pixel\_Type is 32\_BIT\_FLOAT. You can leave all the other boxes empty. You are ready to go so Push OK. A screen will appear that gives you an indication of progress.



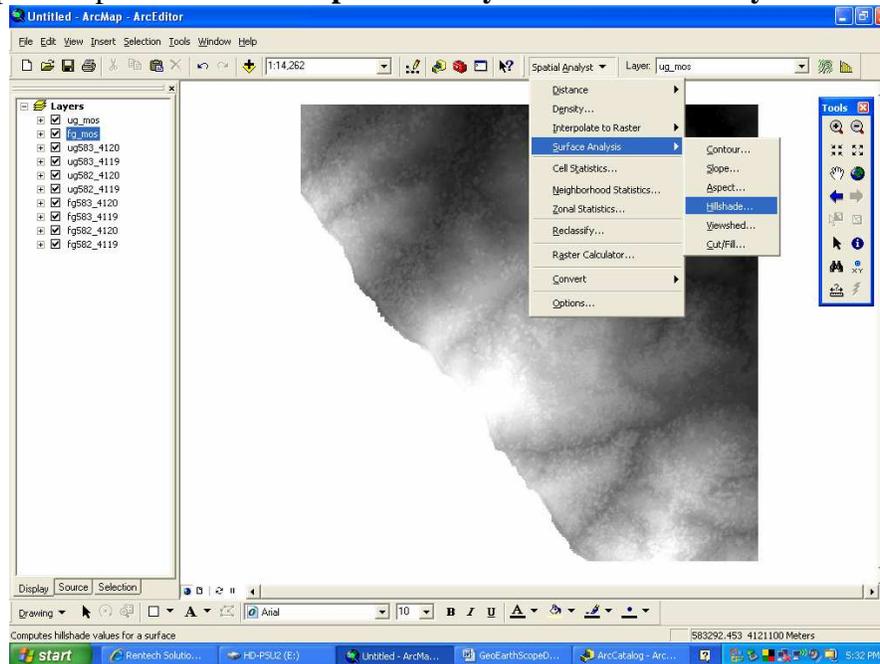
You will see the resulting mosaic appear on the left with the other rasters.

Do it again with the filtered data. Note that I clicked the little – next to the layers so we could collapse the display for them. And, I closed the toolbox.

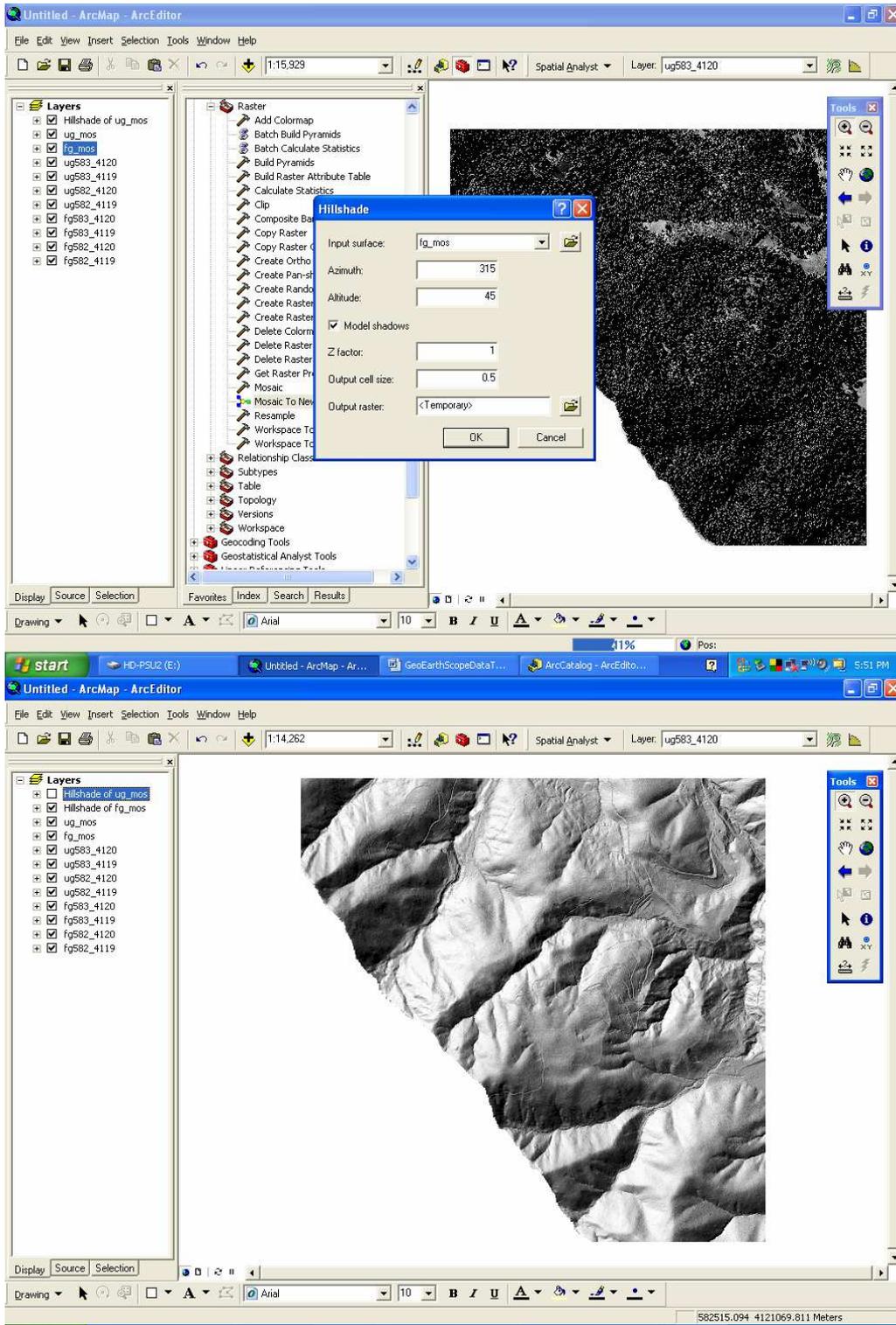


## How to produce a hillshade map

- In order to produce the hillshade map, you will need use the **Spatial Analyst** tool. If you can't find it in your tool bar: Go to **View => Toolbars** and check the **Spatial Analyst**. Now you should find it in the toolbar
- Also, make sure that you have access to some of the essential **Extensions**: Go to **Tools => Extensions** and check the **3D Analyst** and **Spatial Analyst**.
- Now open the pull-down menu **Spatial Analyst => Surface Analysis => Hillshade**



- In the window that will open (figure next page), you can choose the DEM (**Input surface**) from which you want to produce the hillshade map. The following window gives you a couple of options:
  - You may change the **Azimuth** and **Altitude** of the 'sun' that illuminates the region
  - Check the '**Model shadows**' button
  - You may exaggerate the elevations by the **z-factor** -this is especially helpful in flat, low-relief areas.
  - The **Output cell size** tells you the size (in m) of each cell; in our example, the 0.5 is the DEM spatial resolution of 50 cm per pixel)
  - You may want to save the hillshade map (**Output raster**)...

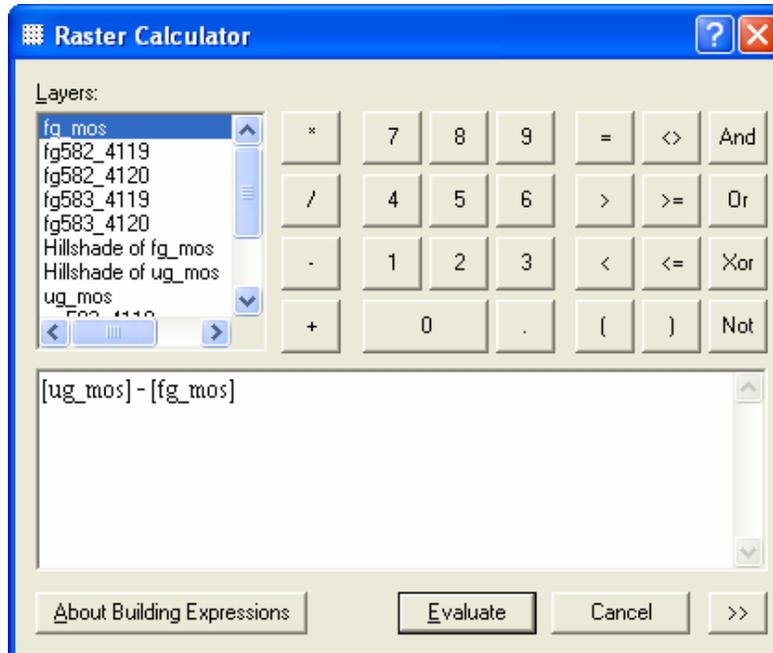


Alternate between the unfiltered and filtered (“bare earth”) DEMs by clicking on the *Hillshade of ug\_mos* and then turning on and off the *Hillshade of g\_mos* Layer which should be above it.

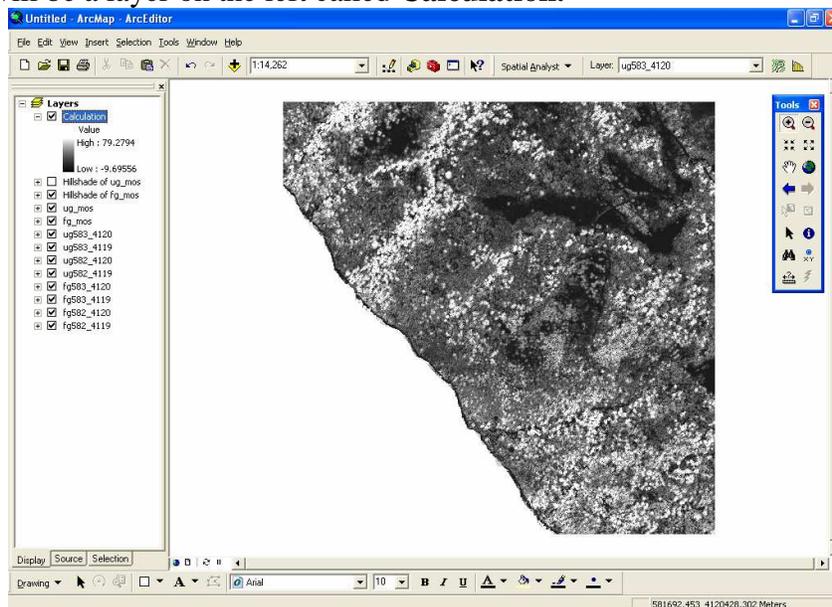
## ***Raster math: subtracting the filtered DEM from the unfiltered DEM to make a canopy height map***

One of the powerful capabilities of ArcMap with respect to raster data is performing mathematical and Boolean operations on the grids. In this case, we will subtract the filtered or bare earth DEM from the unfiltered one (effectively it is the top of the canopy) to produce a canopy height map.

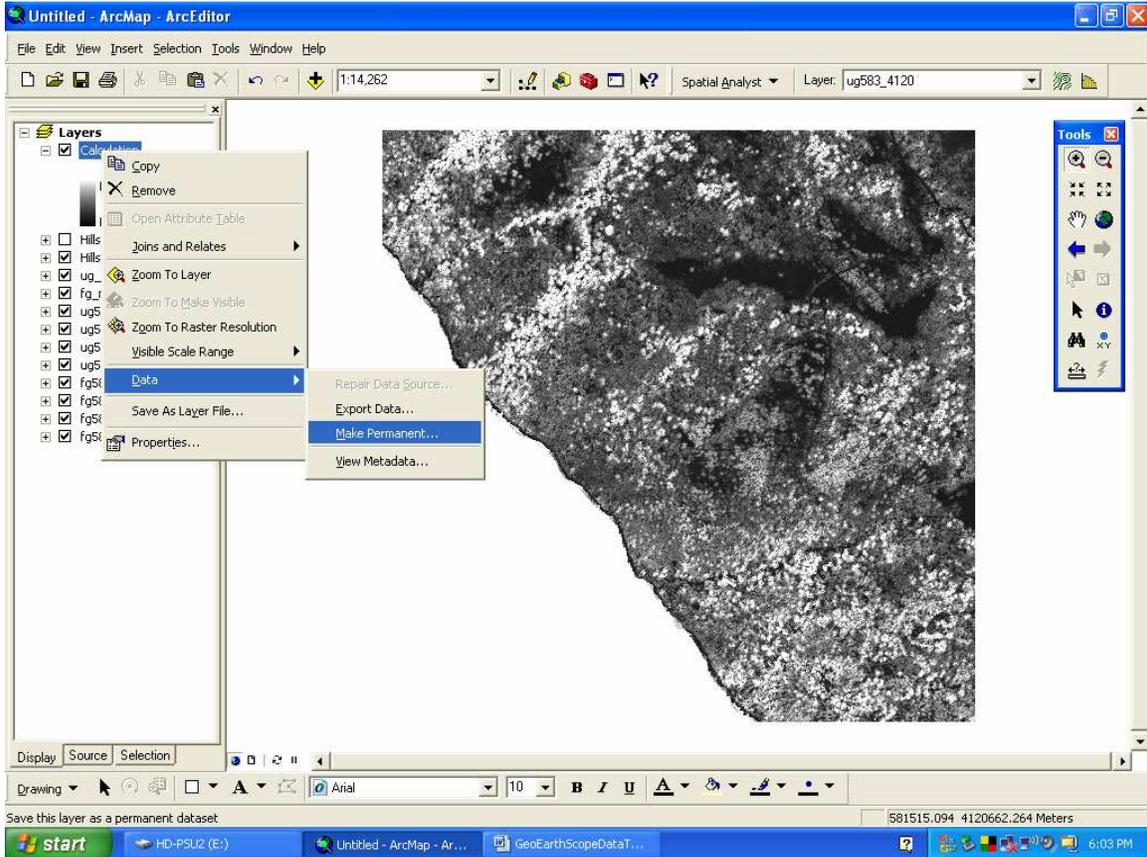
Under Spatial Analyst (see above under Hillshade if you have not gotten it going yet), select Raster Calculator.



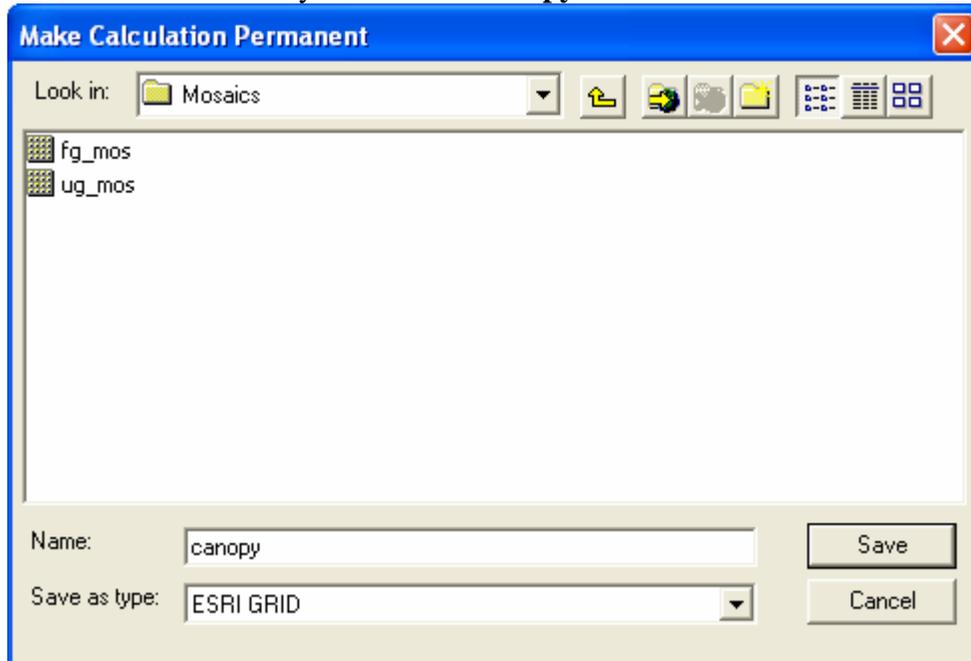
Click on **ug\_mos**, then click the – sign, then click the **fg\_mos** and push *evaluate*. The result will be a layer on the left called **Calculation**.



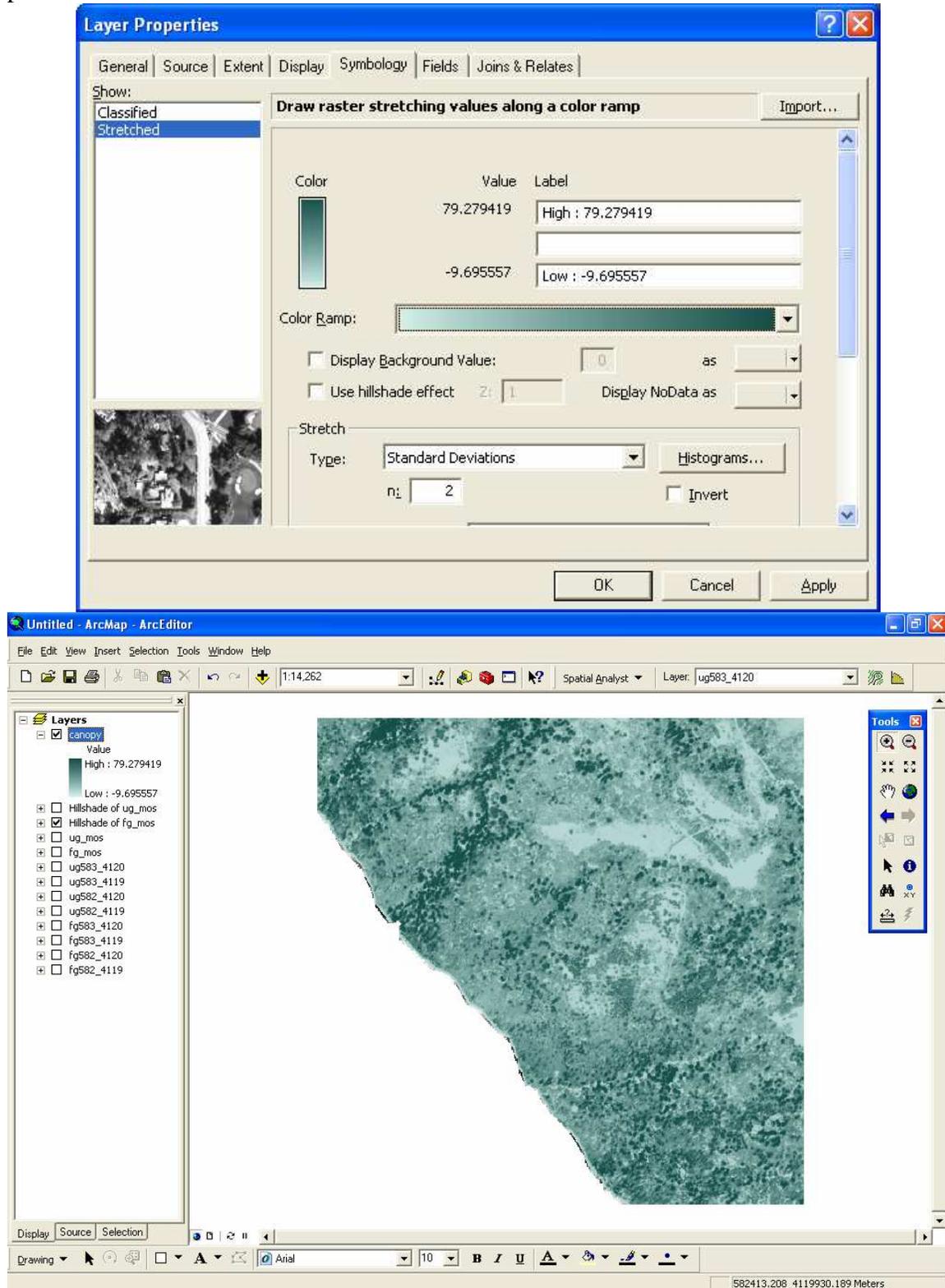
You can make it permanent by right clicking on it, and then selecting *Data->Make Permanent*.



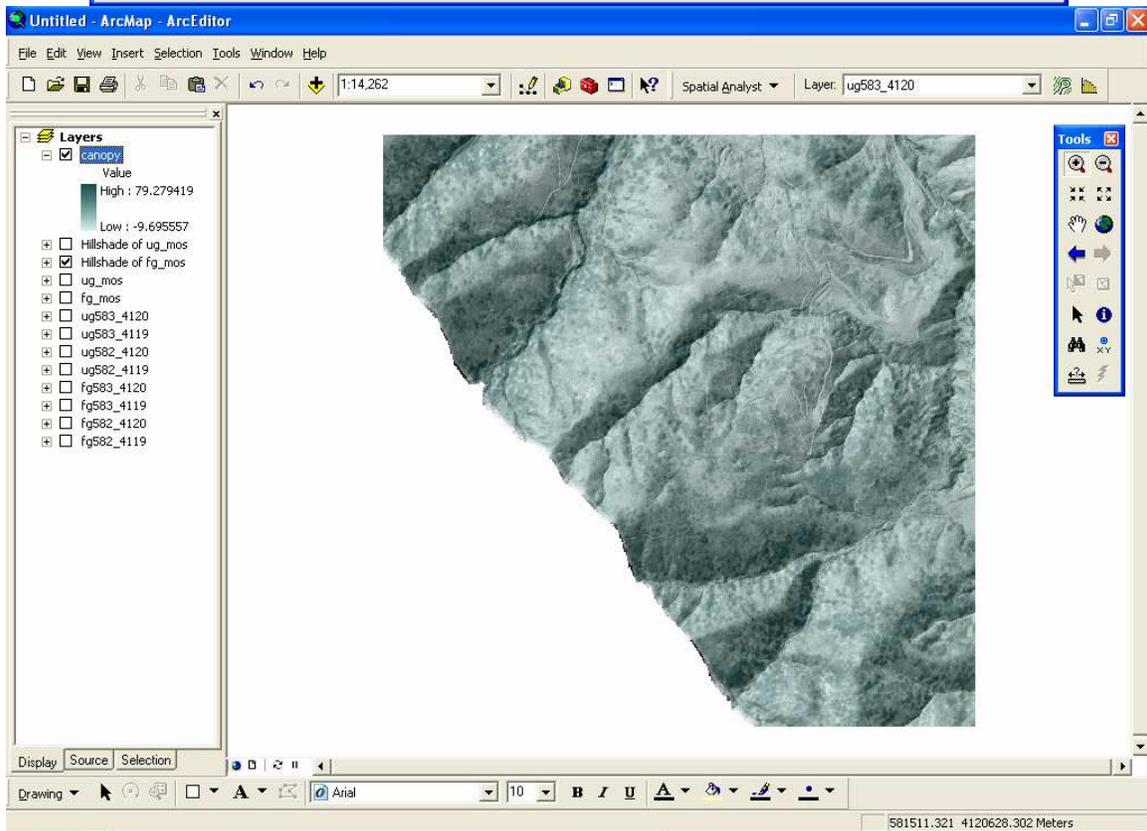
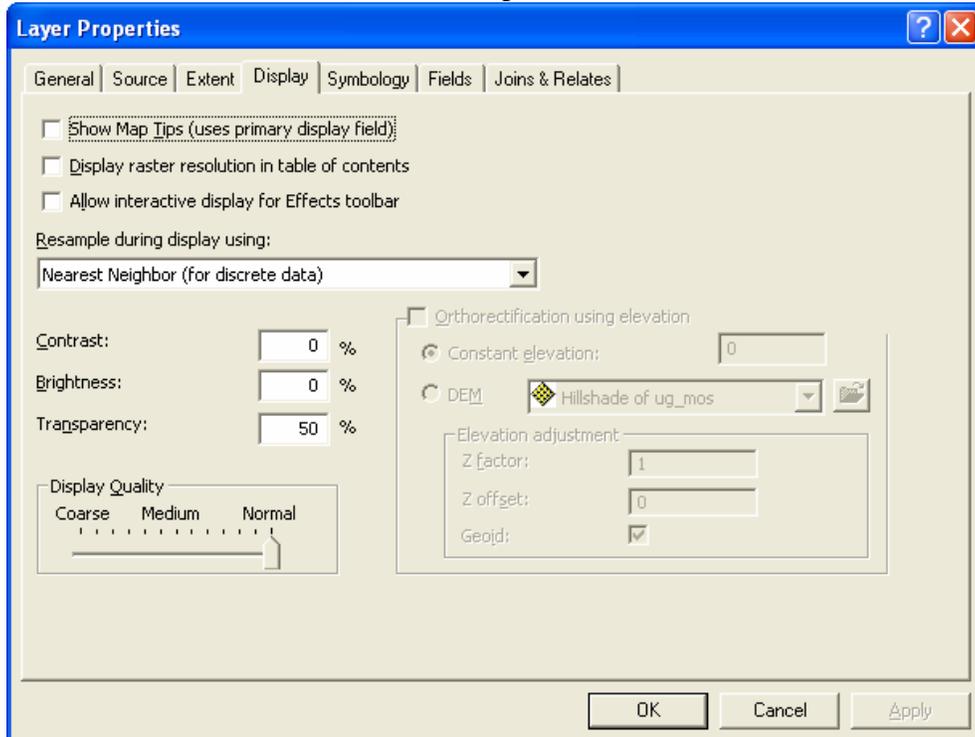
Save it to the Mosaic directory and name it **canopy**.



Remove the **Calculation** from the Layers (right click and select Remove) and then add the **Canopy** raster. Give the **Canopy** a different color map by right clicking and selecting *Properties->Symbology* tab. Choose a different, probably greenish, Color Ramp. Then push ok.



An interesting effect can be achieved by displaying the canopy semi-transparently over the filtered hillshade. It can also be nice on top of the unfiltered hillshade.

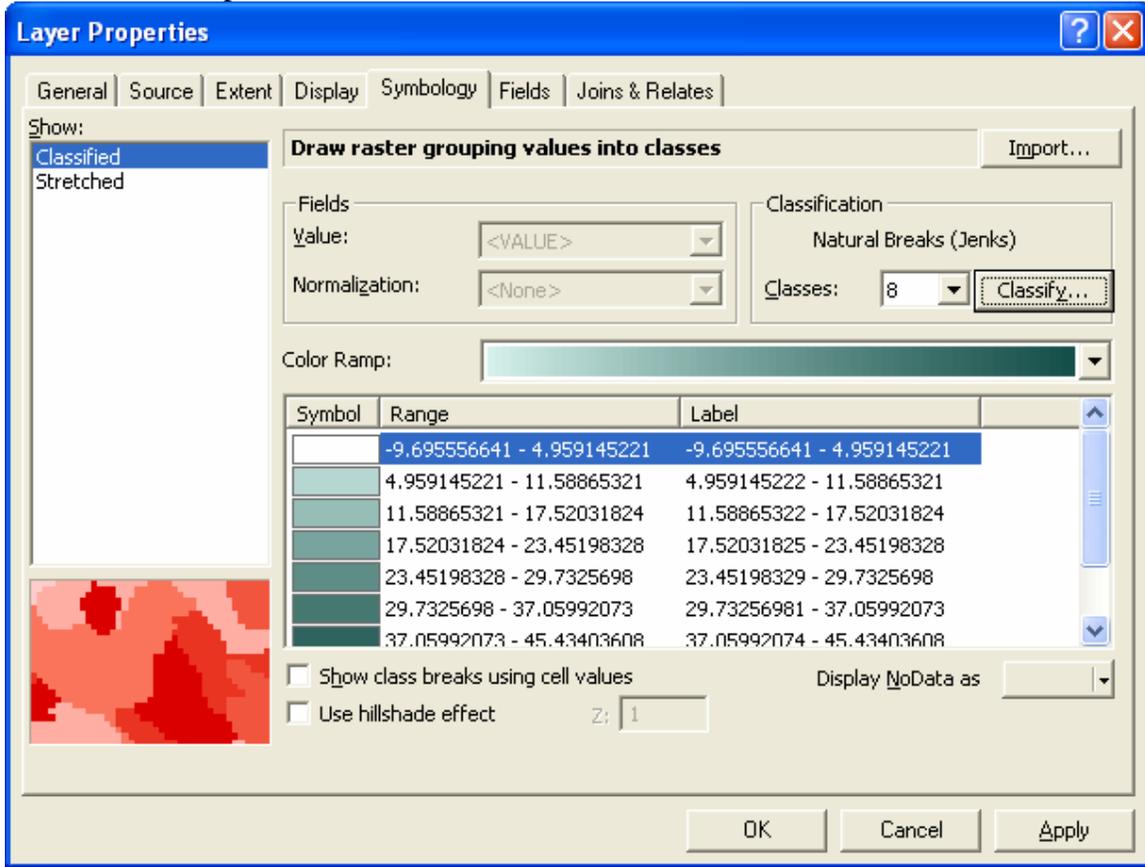


One detail to consider is that some of the canopy values are negative and the lowermost part of the canopy is probably bushes and whatnot. To display the canopy down to let's say 2 meters height, do the following. Right click on the **Canopy** layer and select *Properties->Symbology* tab.

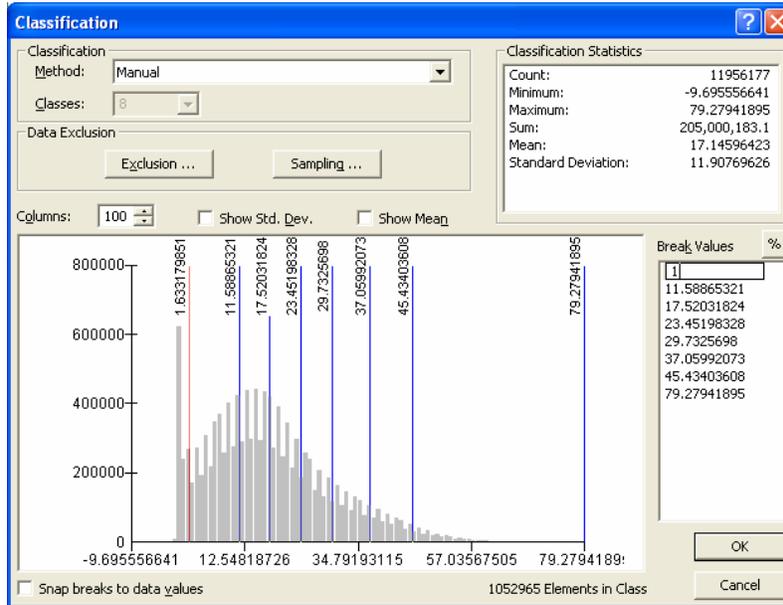
Then Show Classified on the right.

Choose 8 classes.

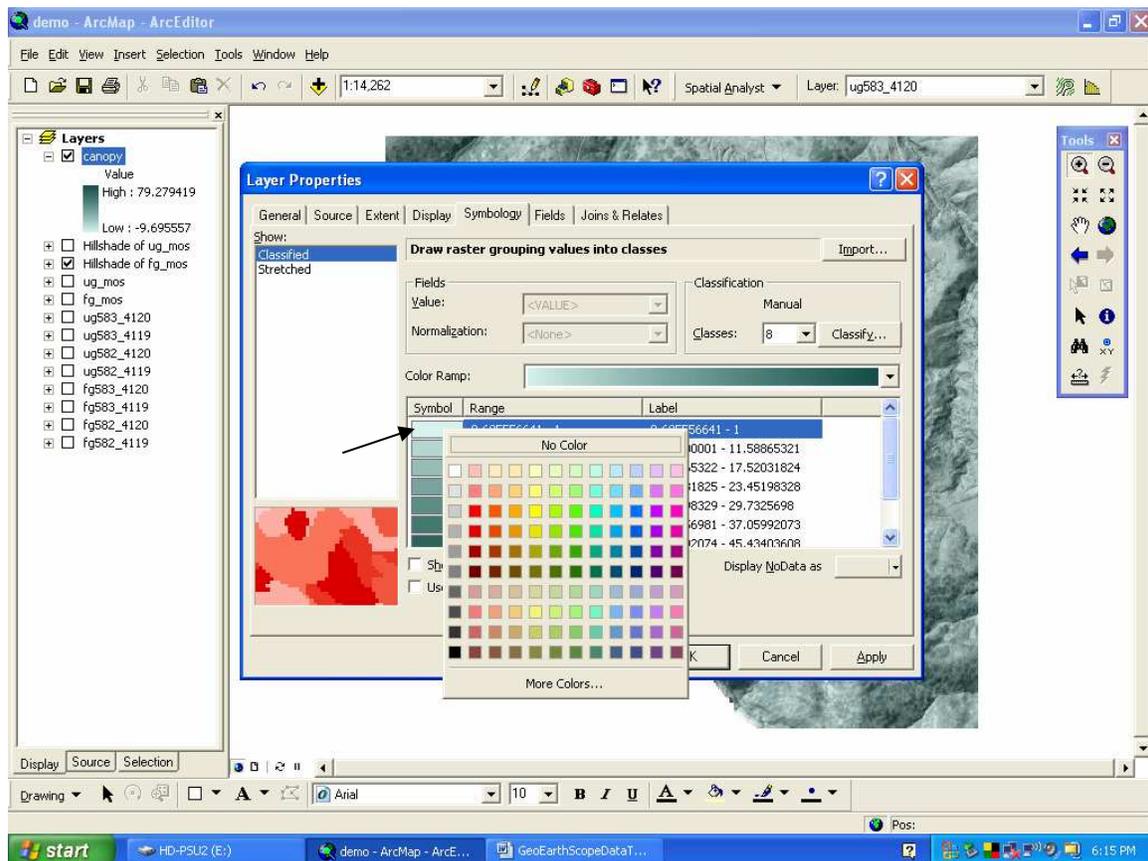
Set the color ramp.



Click on Classify. Change the first break value to 1 or 2 meters. Move the others around if you want.



Then go back and double click on the color box (under the symbol category for the first level and make it *No Color*.



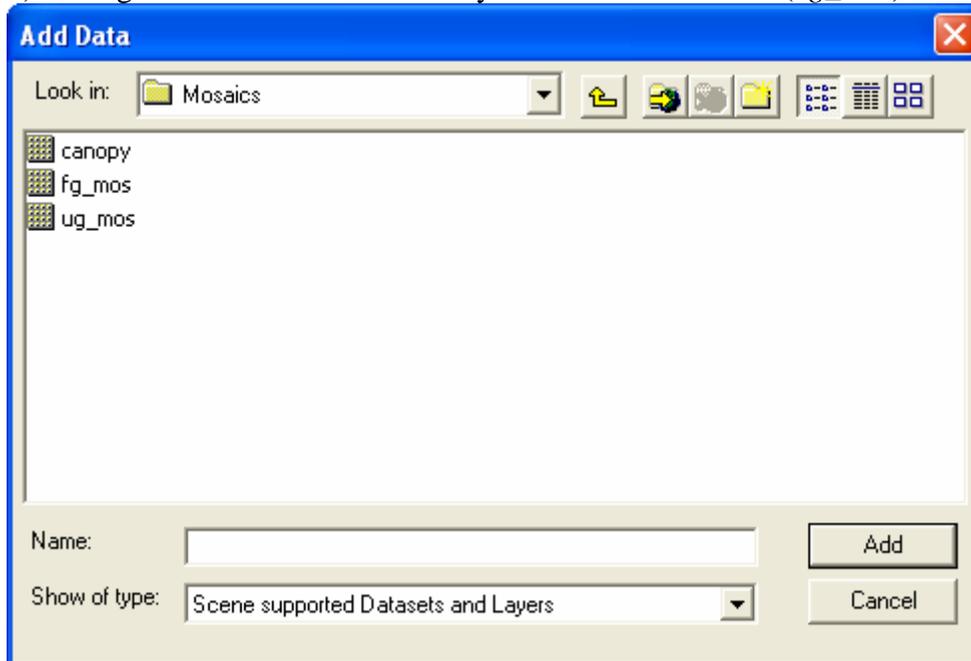
## Arc Scene Demonstration

Viewing the Lidar data in a “3D” view can be astonishing and the viewer can often see many features not evident just in the map view. Thus, we will use the ArcScene program available as part of the ArcGIS suite.

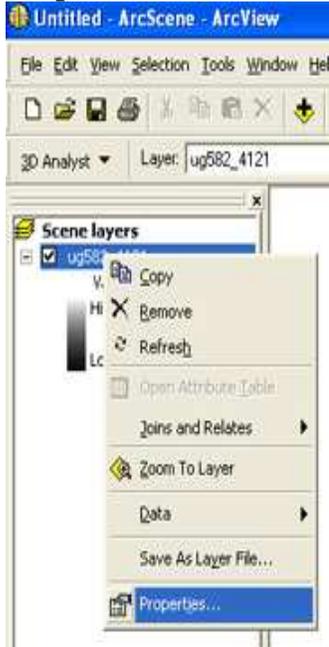
- 1) Quit ArcMap if you have not already and launch ArcScene from Start->All Programs->ArcGIS->ArcScene.
- 2) Click the plus symbol inside the yellow box to add some data:



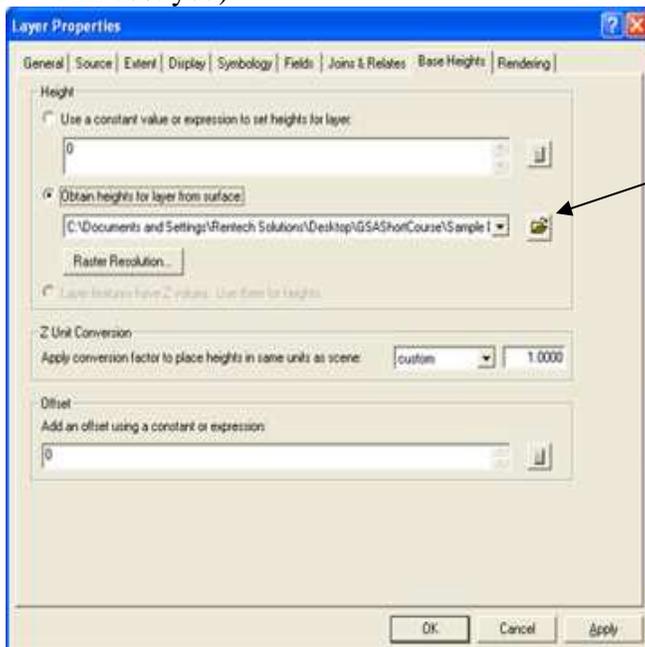
- 3) Navigate to the location and add your Unfiltered Mosaic (*ug\_mos*). .



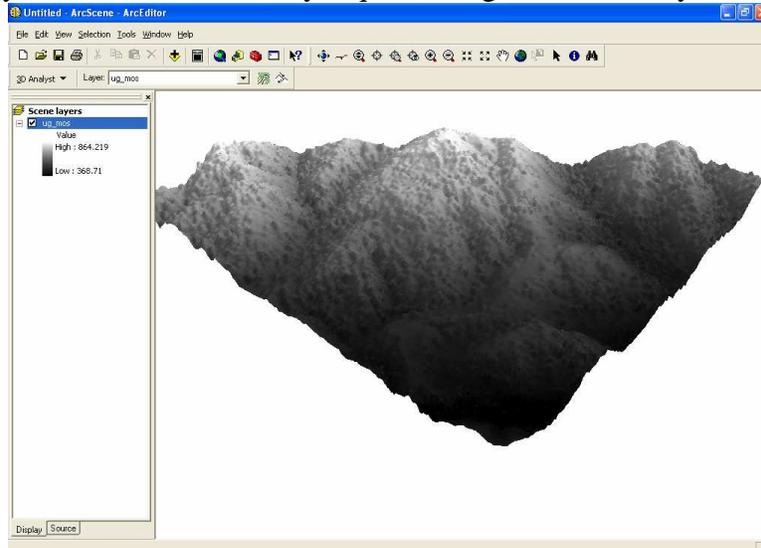
4) Right click on *ug\_mos* Layer in the Table of Contents at left and choose **Properties**.



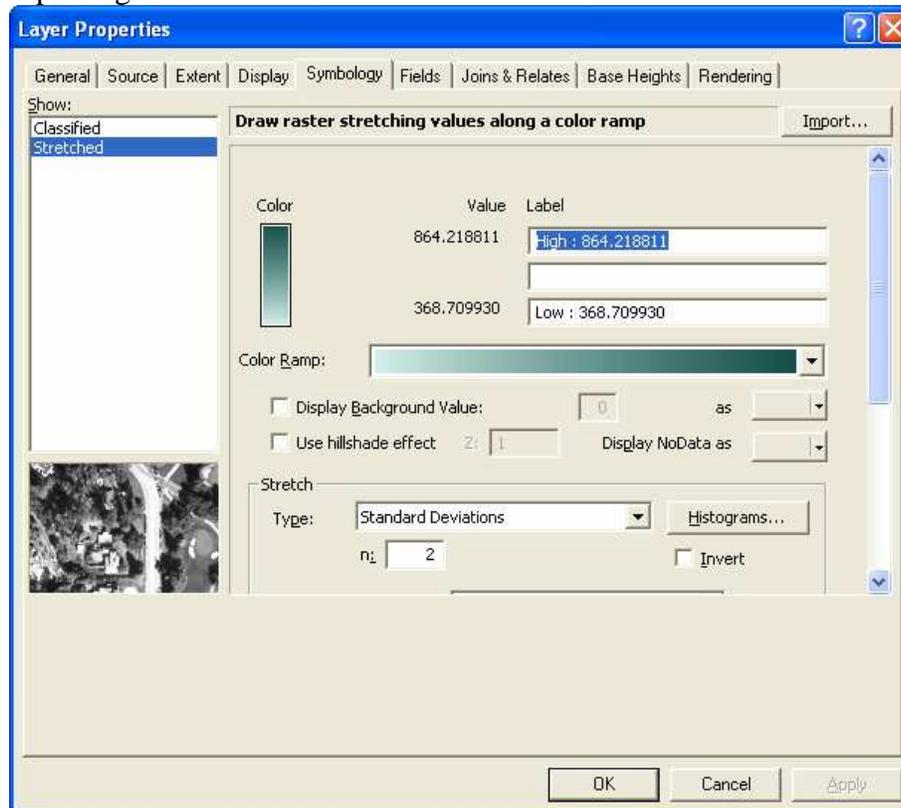
5) Choose the **Base Heights** tab in the next screen. Click on the Obtain heights for layer from surface: and navigate to find the same DEM as you had just loaded (it is going to be “draped” on itself). Push **Apply**. Note that you can come back to this screen and click on the **Raster Resolution** to change the resolution of the resulting image if you want to sharpen it (but watch out for how much memory it will cost you).

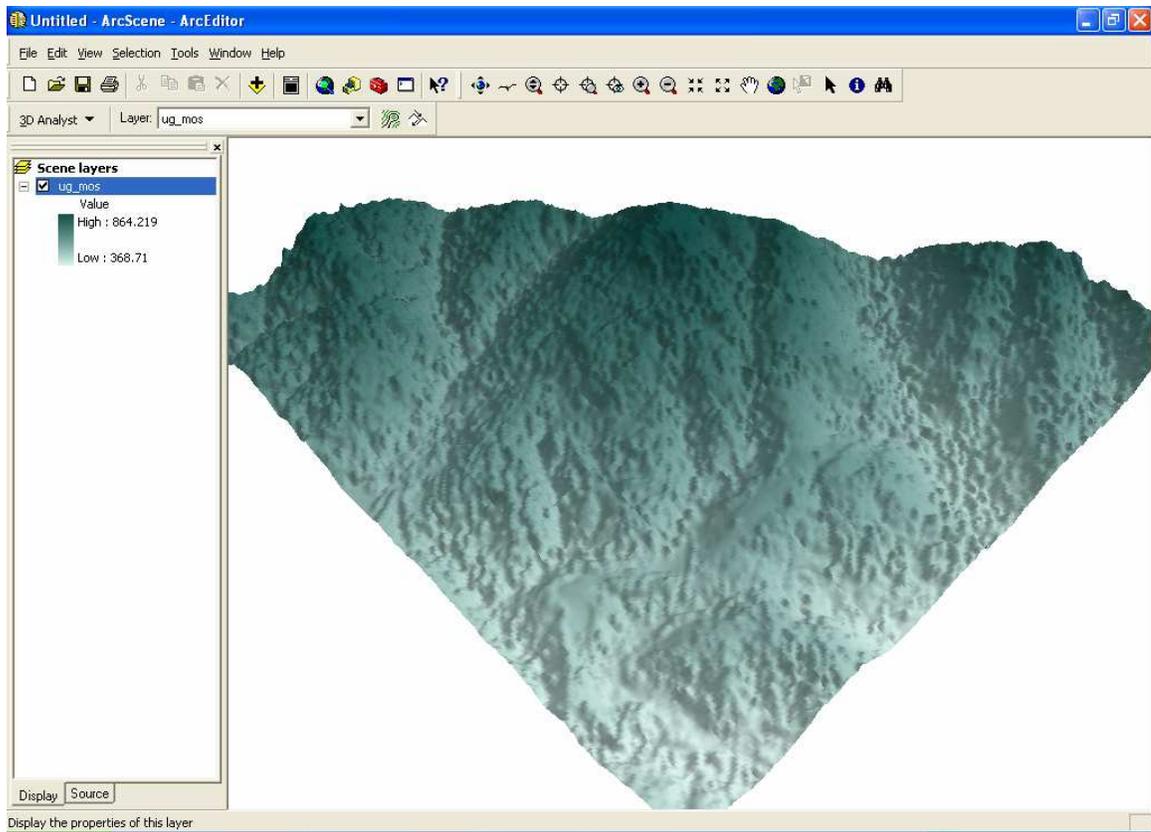


- 6) Choose the **Rendering** tab. Click on the **Shade areal features relative to the scene's light position**. Also, slide the bar for **Quality enhancement for raster images** all the way to the right to **High**. You may get a warning about the memory resources that this may require, but go ahead and try it. Push **Ok**.



- 7) Change the color of the surface. Right click on the *ug\_mos* Layer in the Table of Contents at left and choose **Properties**. Select the **Symbology** tab and change the color ramp to a greenish one.





Repeat for the other files and try some other symbology.

8 The main navigation controls for ArcScene are in the menu bar at the top:

