

This folder and subfolders contain data for ArcGIS geoprocessing tools. The folder can be placed anywhere on your computer so long as you do not edit or delete any of its subfolders. In order to use the tools, open ArcToolbox within ArcMap and right click ArcToolbox root. Click “Add Toolbox” and navigate to the MODIS_Tools folder. Highlight MODIS.tbx and click “Open.” This will import the MODIS toolbox into ArcMap. **This toolbox is coded in ArcPy for ArcGIS 10.**

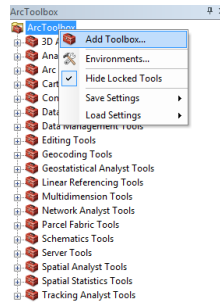


Figure 1 – Add Toolbox

1. Import Evapotranspiration

The Import Evapotranspiration tool allows you to easily access historical evapotranspiration data for any land surface. It imports the MOD16 global evapotranspiration product, which was developed by Dr. Qiaozhen Mu at the University of Montana. MOD16 is a level 4 data product derived from other MODIS products such as land surface temperature (MOD11) and albedo (MOD43). Using these data products and the Penman-Monteith equation, Dr. Mu has estimated monthly averages of actual evapotranspiration for the entire globe with 1 km resolution. These estimates are available for every month going back to January 2000, when NASA first launched MODIS aboard the Terra satellite.

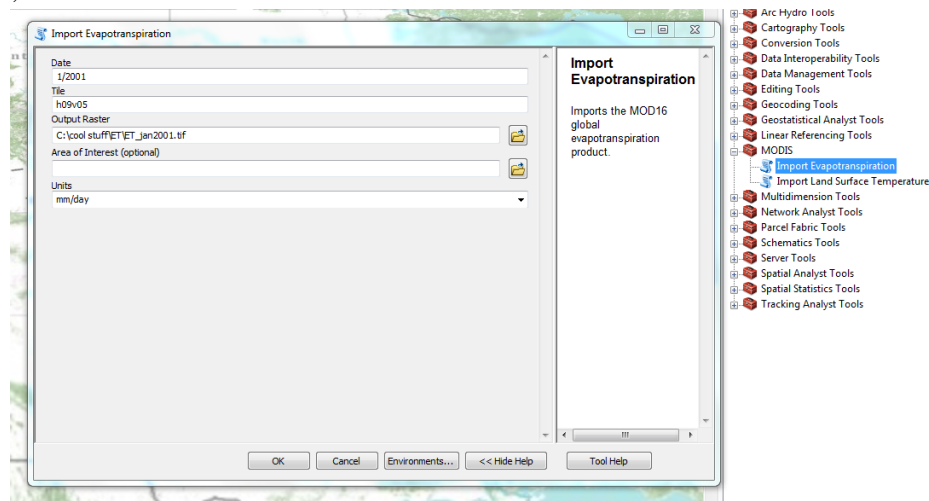


Figure 2 - Import Evapotranspiration

When you click the “Import Evapotranspiration” tool, you will be presented with the window shown in Figure 2. This window allows you to select the month and tile you would like data for. Determining which tile your area of interest lies within can be tricky. MODIS uses a grid based on a sinusoidal projection, shown in Figure 3. Only grid tiles that contain land surfaces are valid inputs to this tool.

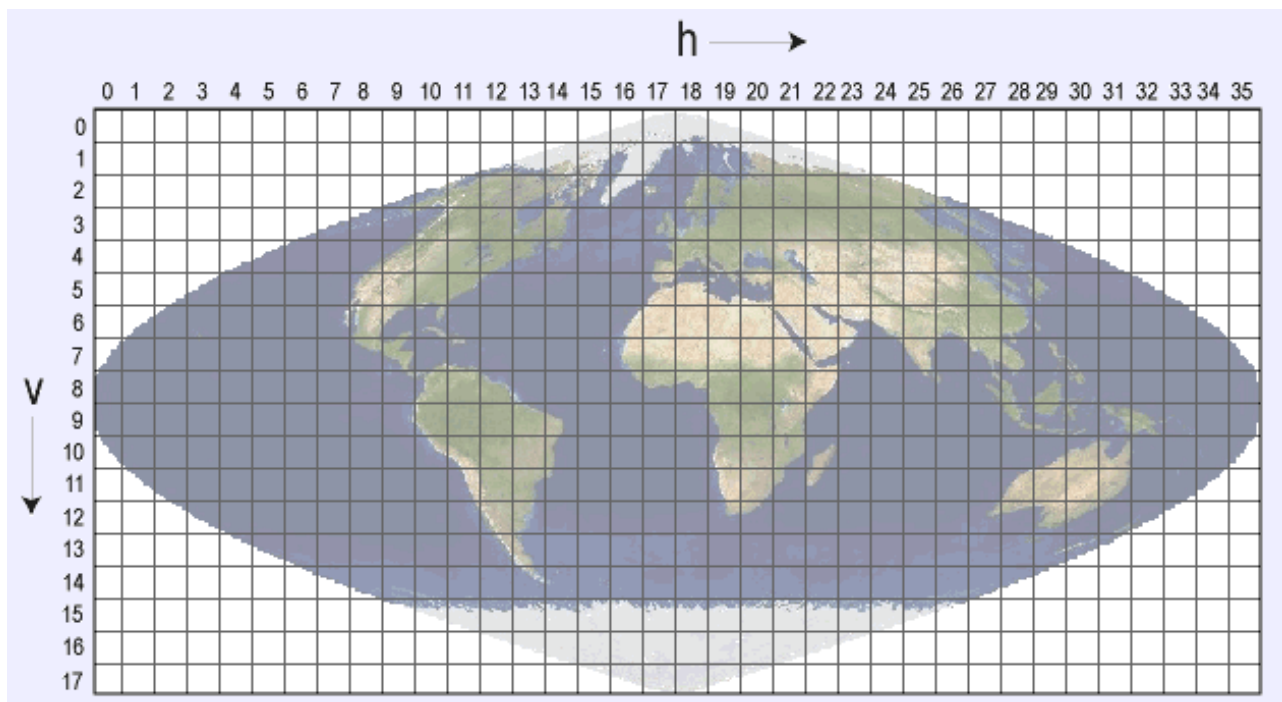


Figure 3 - MODIS Grid

If you are interested in Cambodia, for example, than the relevant tile is h28v07. If your area of interest spans across multiple tiles, it is possible to import them all at once with a batch run. Simply right click on the “Import Evapotranspiration” tool and click “Batch...” The rasters will be saved to whatever location you specify using the “Output Raster” parameter. Remember that you cannot save a raster into a geodatabase. This parameter also allows you to name each raster and the format you wish it to be saved in (jpg, png, bmp, etc). If you don’t add an extension to the filename, it will be saved as an ESRI GRID. Once the tool has successfully run, you can press the “add data” button in ArcMap, navigate to the folder

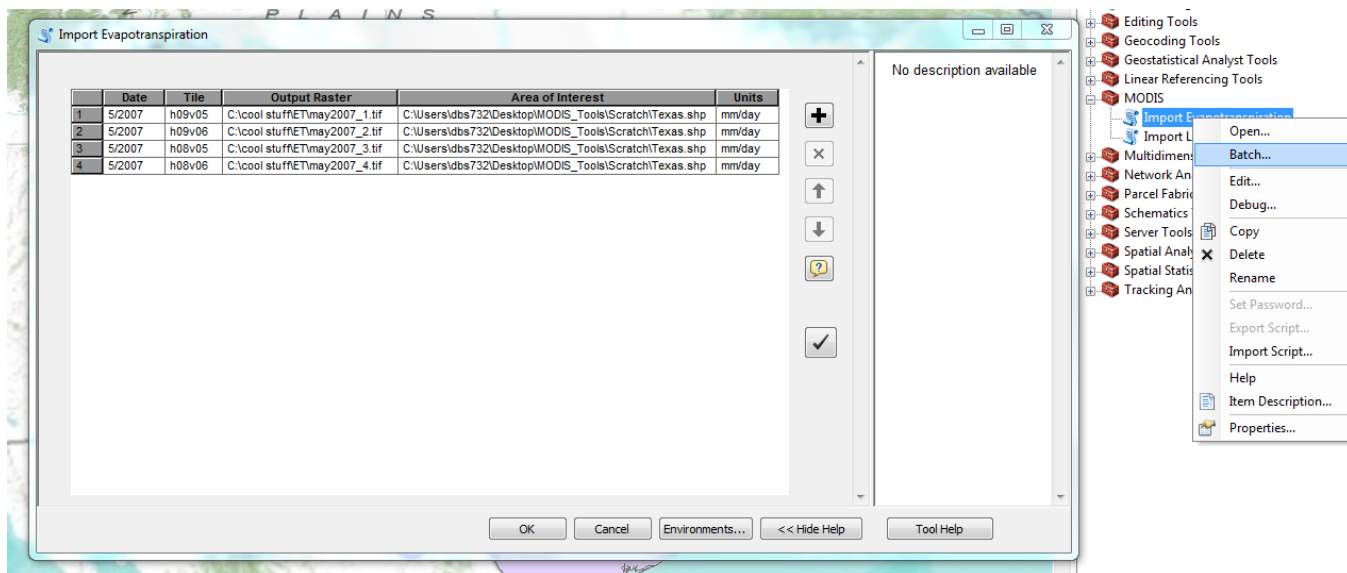


Figure 4 - Batch Run

you specified, and select the rasters you just created. If your area of interest is made up of multiple tiles, you can use the “Mosaic to New Raster” tool to fuse them together into a single raster. **Make sure to specify “32_BIT_FLOAT” as the pixel type or else data will be lost.**

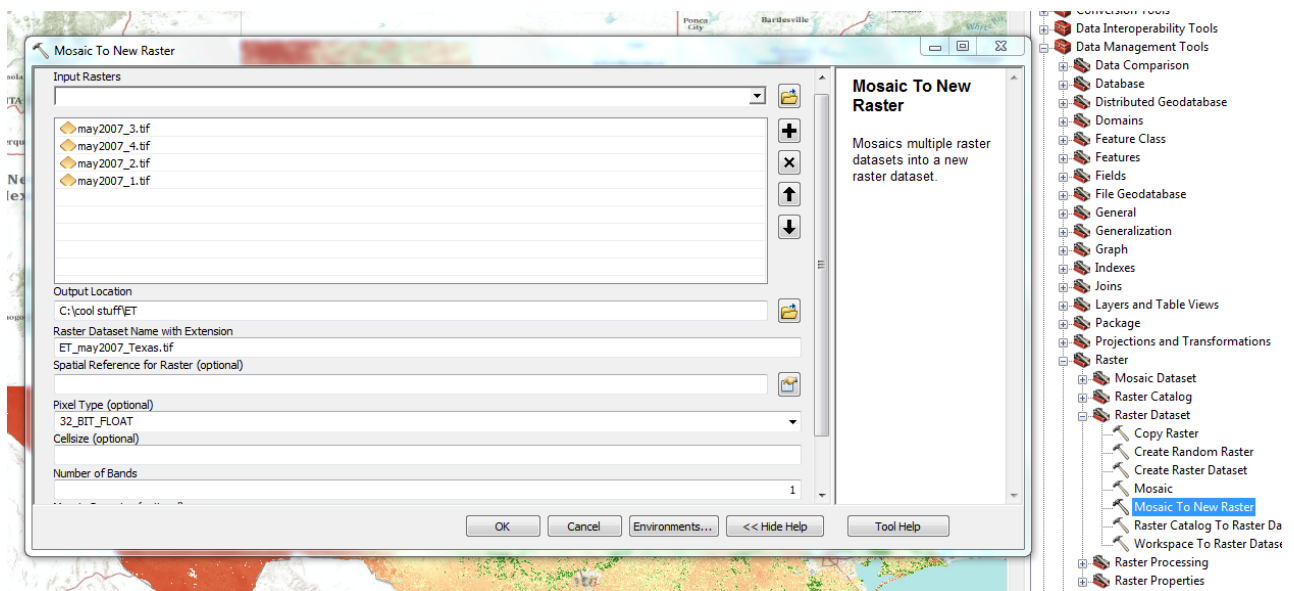


Figure 5 - Mosaic to New Raster

If your raster looks distorted, this is ArcMap is attempting to project the dataframe into sinusoidal coordinates. Right-click on “Layers” within the Table of Contents, click properties, and set the coordinate system to whatever you like. This step can be avoided by ensuring you already have a basemap or other layer open in ArcMap before importing a MODIS raster.

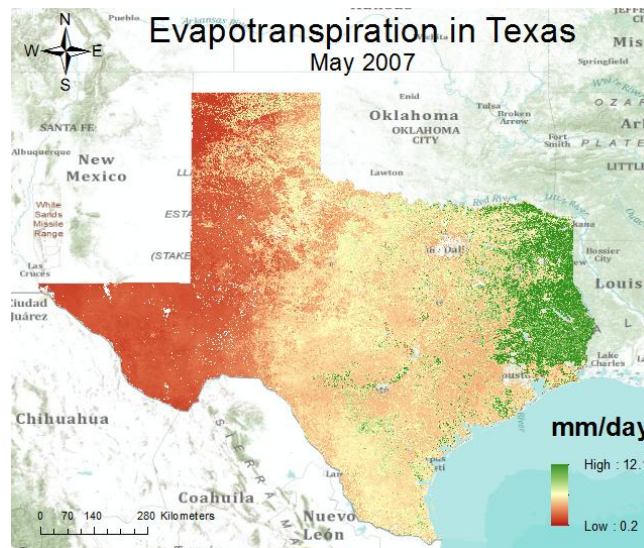


Figure 6 - Output Raster

An example of the kind of maps you can create using this tool is shown in Figure 6. Also, by opening the “symbology” tab of the raster’s layer properties and clicking “classify,” you can view the statistical

distribution of evapotranspiration in your area of interest. Multiply the mean by the surface area to calculate the total volume of water lost to evapotranspiration.

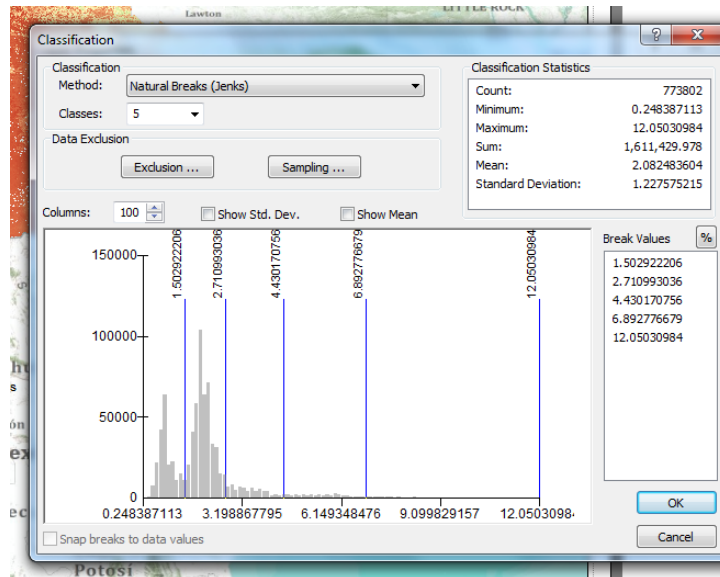


Figure 7 - Classification Statistics

2. Import Land Surface Temperature

The Imports Land Surface Temperature tool accesses MOD11-A1, the daily averaged land surface temperature product. The MOD11 product uses historical data from MODIS and the generalized split-window LST algorithm developed by researchers at the Goddard Space Flight Center. This algorithm is optimally used to separate ranges of atmospheric column water vapor and lower boundary air surface temperatures into tractable sub-ranges.

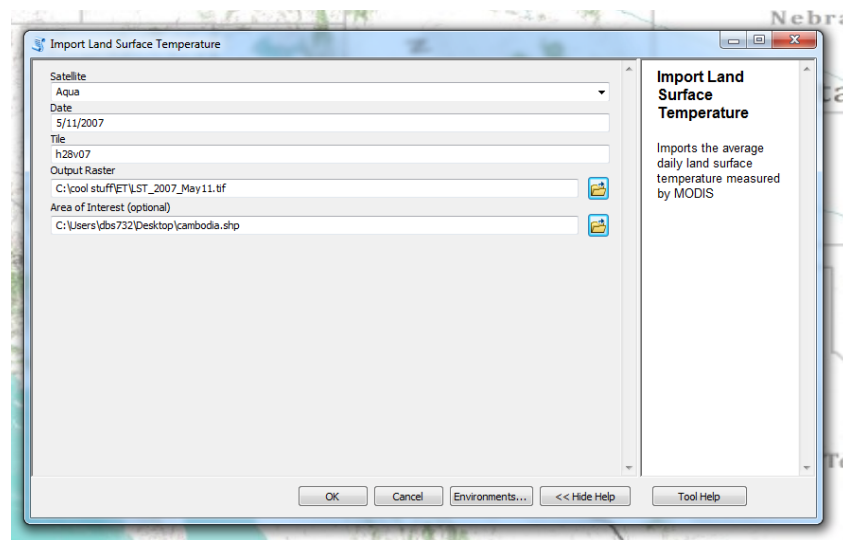


Figure 8 - Import Land Surface Temperature

Use of the Import Land Surface Temperature tool is similar to the Import Evapotranspiration tool. The crucial difference is time support. While MOD16 is averaged over each month, this tool provides daily averages. In fact, it is possible to access two different rasters for any given day – based on imagery from Aqua and from Terra. The two satellites have different overpass times, so on any given day one might provide significantly better imagery than the other. These images are often incomplete because any pixel obscured by clouds has been labeled “NoData.” It is not recommended that you mosaic images from different satellites together.

3. Vegetative Indices

There are two vegetative indices you can import using this toolbox. Researchers at the Goddard Space Flight Center compute them from atmospherically corrected bi-directional surface reflectances that have been masked for water, clouds, heavy aerosols, and cloud shadows. Blue, red, and near-infrared reflectances, centered at 469-nanometers, 645-nanometers, and 858-nanometers, respectively, are used to determine to "greenness" of each pixel. The scale is from 0 (rock) to 1 (total canopy cover). Negative numbers indicate open water.

The normalized difference vegetation index (NDVI) is a venerable indicator first measured by the Landsat I in 1972. It is calculated according to the formula

$$NDVI = \frac{(NIR - VIS)}{(NIR + VIS)}$$

where NIR is the near-infrared radiance and VIS is observed radiation in the visible spectrum. Over the years, many attempts have been made to improve upon this humble formula, and the enhanced vegetation index (EVI) was developed in 1999 to take advantage of the advanced capabilities of MODIS. EVI minimizes canopy background variations and maintains sensitivity over dense vegetation conditions. The EVI also uses the blue band to remove residual atmosphere contamination caused by smoke and sub-pixel thin cloud clouds. Both vegetative indices are monthly averages, and are available from either satellite with MODIS (Aqua or Terra).

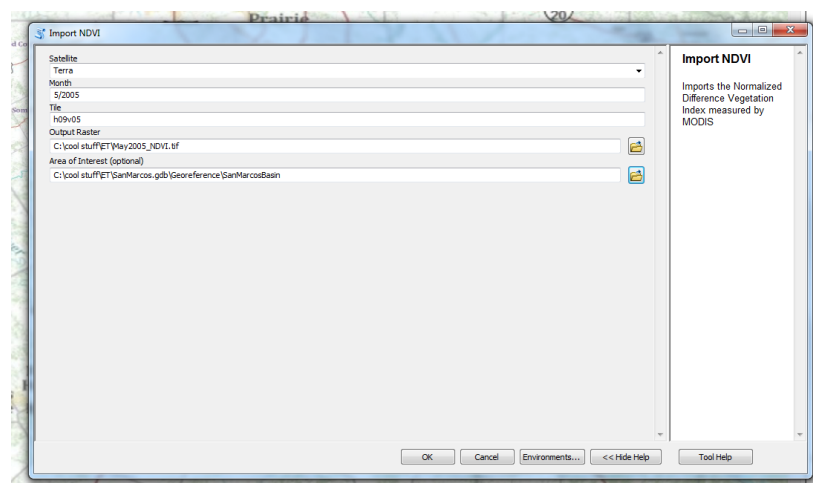


Figure 9 - Import NDVI