

Creating PET Adjustment Coefficients

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I. Computing Daily Solar Radiation

In ArcToolbox: Spatial Analyst Tools – Solar Radiation – **Area** Solar Radiation.

Use default values except for the following:

- Input Raster = study area’s DEM
- Output global radiation raster = R, day #, DT: e.g. R094_64
- Latitude = latitude of the site (*computed automatically, but must be entered if done in batch mode*)
- Sky Size = 512
- **Within A Day (12 separate runs for each year, unless D&T are the same for the particular day).**
*In this sample, the DT values were determined according “Parameterizing Diffuse Proportion & Transmittivity Values...Creating Radiation Grids,” and are used to create the monthly radiation grids used in the computation of monthly PET grids. **THESE DT VALUES ARE ONLY SAMPLES AND WILL BE DIFFERENT FOR YOUR STUDY AREA.***

Date	Day Number	D	T
4-Apr	94	6	4
20-Apr	110	6	4
5-May	125	2	5
21-May	141	2	5
5-Jun	156	5	4
21-Jun	172	5	4
6-Jul	187	7	3
22-Jul	203	7	3
6-Aug	218	4	5
22-Aug	234	4	5
6-Sep	249	2	6
22-Sep	265	2	6

- Select the day number (the year is irrelevant, only used for determining leap year)
- Start/Stop times = 0/24 (do not apply “Time Conversion”)
- Hour Interval = 1
- Check “Create output for each interval”

Topographic Parameters

No changes; use default “slope and aspect from DEM”

Radiation Parameters

- Azimuth division = 16 (leave Zenith = 8)
- Diffuse Proportion – *from the table above*
- Transmittivity – *from the table above*

To determine the hour that the “c0 grid” (the first daylight hour) corresponds to:
Run “Points Solar Radiation” (similar parameters as with Area)

- Input raster = same DEM
- Input points feature = point shapefile within DEM
- Output global radiation feature = R, day#, DT, 0* (e.g. R094_64_0)
- Sky size = 512
- “Within a Day” time configuration
- Select the day number (the year is irrelevant, only used for determining leap year)
- Start/Stop times = 0*/24
- Hour Interval = 1
- Check “Create output for each interval”
- Radiation Parameters: 8 (zenith)/16 (azimuth), D & T values from the table

*Then repeat, but change start time to hour containing sunrise, based on data compiled from the NOAA Solar Calculator (<http://www.esrl.noaa.gov/gmd/grad/solcalc/>). See sample Excel spreadsheet, “PET_Adjustment_Sample.xlsx” (“Sunrise Info” worksheet).

- Change grid name from “0” to new start hour, e.g. R094_64_6
- Look at two resulting attribute tables. If T0 value is identical, then you have properly identified the starting hour. If there is a discrepancy, try shifting the Start time an hour earlier, and compare results to the 0-24 results.
- Once start hour is identified, note in the “PET_Adjustment_Sample.xlsx” spreadsheet – which hour is c0, c1, etc.

II. Calculating Daily PET

[note: ArcGIS v. 9.3 numbered radiation grids beginning with “0,” e.g. rad_c0. ArcGIS v. 10 appears to begin with “1,” so in the text below, rad_c0 would be rad_c1]

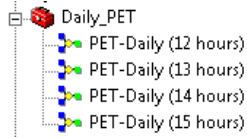
After “Computing Daily Solar Radiation,” – run on both grids and points, you will know which hour of the day the first radiation grid (rad_c0) corresponds with. For example, if rad_c0 corresponds with the 6-7 am hour, temperature for the end of the hour (i.e., 7 am) is associated with that radiation grid. This information is included in the spreadsheet of corresponding temperature factors. Note that some sites/days will have anywhere from 12-15 hours of daylight. There is a separate model for 12-, 13-, 14-, and 15-hour days.

Calculating Daily PET

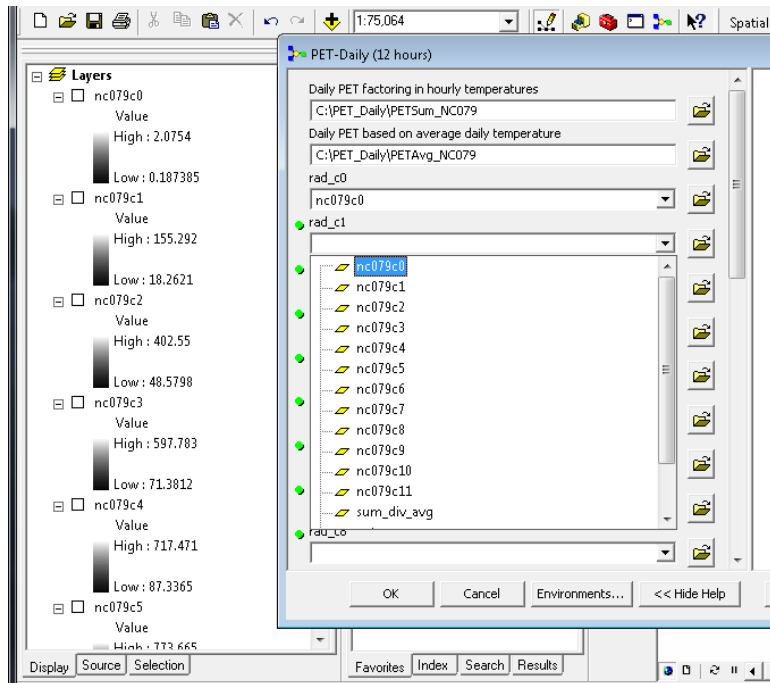
Needed Data:

- Hourly grids of radiation for study site (rad_c0, rad_c1...)
 - Spreadsheet of corresponding temperature factors. (See “PET_Adjustment_Sample.xlsx”)
 - Create folder on local C: drive:
 - C:\PET_Daily
- And within it, create a “Working” folder:
- C:\PET_Daily\Working

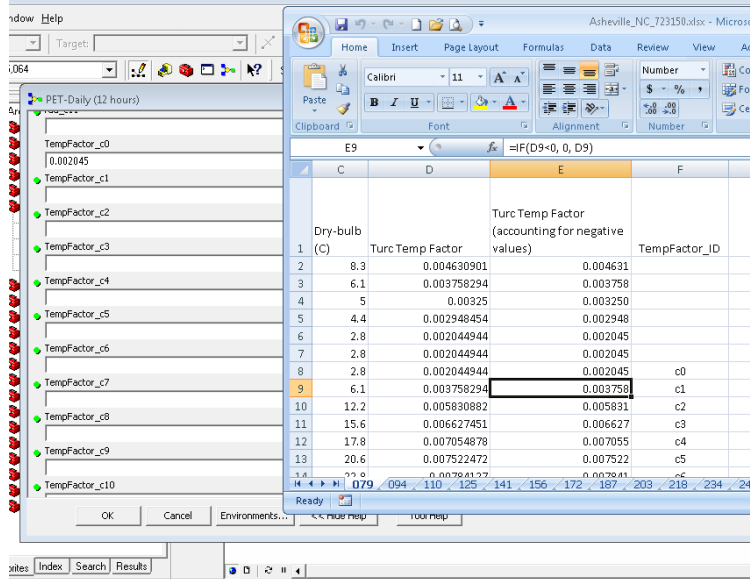
1. In ArcGIS, add the toolbox “Daily_PET” and open the appropriate “PET-Daily” model



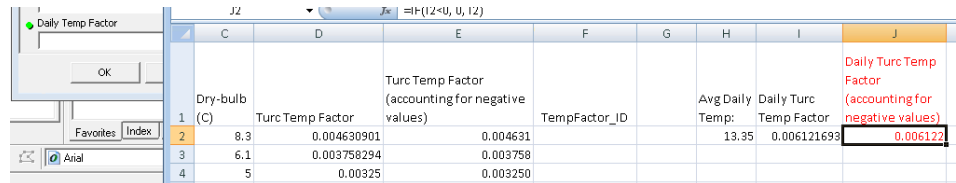
- Add the site and day number to the two PET grids to be computed (e.g. C:\PET_Daily\PETSum_094_64, C:\PET_Daily\PETAvg_094_64)
- In the screen capture below, the grids were named C:\PET_Daily\PETSum_NC079, C:\PET_Daily\PETAvg_NC079 (the DT values were not included with the name in this example).
- Select the appropriate radiation grids (rad_c0, rad_c1...). [These don't necessarily need to be in C:\PET_Daily, or added to the Table of Contents.]



d. Copy and paste the Temp_Factors from the spreadsheet to the model window.



e. Likewise copy and paste the Daily Temp factor



f. Hit OK.

III. Creating PET Adjustment Coefficient Grids

The purpose of these routines is to adjust PET grids based on temperature variation throughout the day. Max radiation occurs on south slopes, but temperatures continue to warm throughout the day, reaching its max when radiation is focused on westerly slopes. (PET = f(radiation and temperature)). We are only working on “growing season grids” – April-September.

This tool also requires the slope grid derived from the study area DEM.

If necessary, add Daily_PET Toolbox to ArcGIS. You used this (Part II above) to create the Daily PET grids.

- You will need the “PETSum” and “PETAvg” grids for the next step. Both represent a daily value for PET, but are computed differently. PETSum is the sum of PET for each hour in the day (computed using hourly temperatures); PETAvg uses the average daily temperature for each hour.

Open the tool “2. Sum Monthly PET (apr-sep only)”

- This tool sums the two daily grids for each month (e.g. PETSUm_094 + PETSUm 110 = PETSUm_Apr). It then takes the monthly Sum grid and divides it by the monthly Average grid to create a ratio (e.g. PETSUm_Apr ÷ PETAvg_Apr = sumdavg_apr).
- Enter the PETSUm and PETAvg grids in the dropdown boxes.
- Hit OK.

Open the tool “3. Zonal Stats – Flat Sites (apr-sep only)”

- This step computes the average ratio of Sum vs. Avg PET (e.g., sumdavg_apr99) for flat sites (0-1° slope). These sites should presumably need no PET adjustment, since topography does not affect their PET throughout the day.
- In the dropdown boxes, enter the SLOPE grid, as well as the monthly “sumdavg” grids.
- Hit OK.

Open the tool “4. PET-Coefficient (apr-sep only)”

- This final tool creates a grid of PET adjustment factors, by standardizing the “Sum divided by Average” PET grids (Step 2) by its value on flat sites (“Flat Average,” Step 3). This grid can then be used to multiply the unadjusted PET grids created by the Water Balance tool.
- In the dropdown boxes, enter the values from the monthly “flatavg” grids. **IMPORTANT: DO NOT ENTER THE GRID NAME IN THIS BOX.** (Otherwise it will only operate on the flat sites.) **YOU MUST ENTER THE ACTUAL VALUE FROM THE GRID.** (You can cut-and-paste from the grid in the Table of Contents.)
- Hit OK.

IV. Using the PET Adjustment Coefficient Grids

The PET Adjustment Coefficients represent the value, for each pixel, that PET is increased or decreased, based on its topographic position. With these adjustment coefficient grids, you will skip the “**1B PE Adjust**” steps in the Water Balance User Manual. Instead, after creating your monthly PET grids (using the “1: Turc PE” tool), multiply each month’s PET grid by its associated PET Adjustment Coefficient grid (*Spatial Analyst Tools – Math – Times*). To keep with naming conventions in the model, the output grids should be named *pet_adj_04*, *pet_adj_05*, etc. The model uses adjusted PET for the growing season months, April-September (months 04-09).