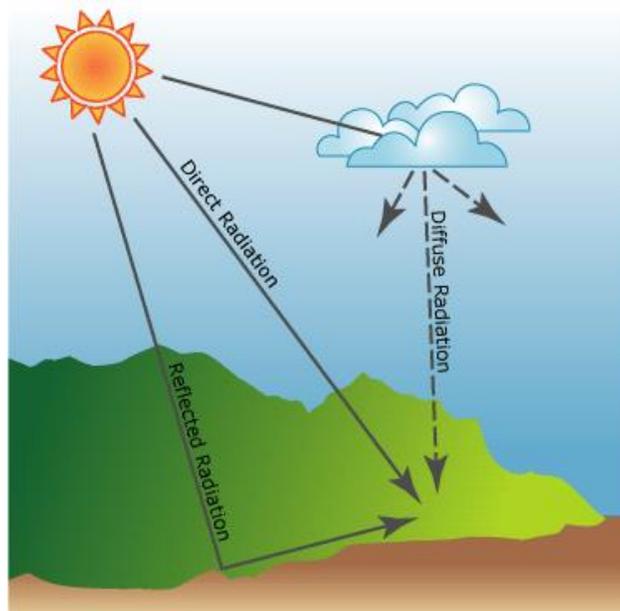
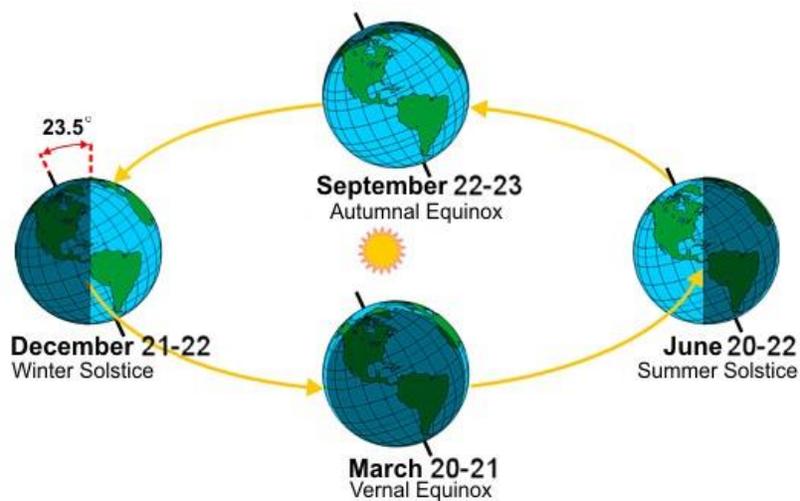


## Cookbook 21 October 2013

### *Raster Data and Spatial Analyst (Part 3)*

#### Overview

1. The Wind – Solar Farm
2. Solar Radiation Modeling
3. Solar Radiation Modeling Tools in ArcGIS



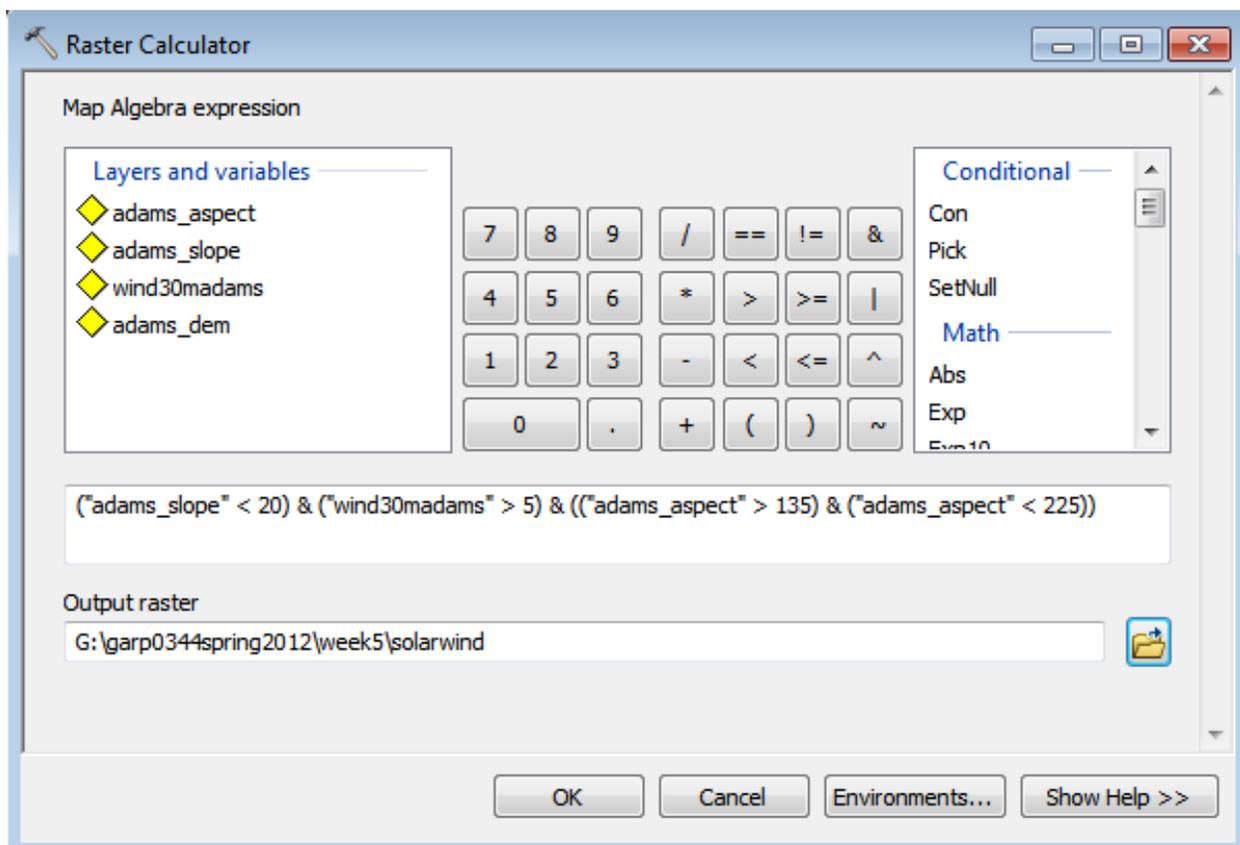
## 1) The Wind – Solar Farm

### Site Selection Criteria:

- The site has to have a slope angle of 20° or less (it also can be flat).
- The slope has to have a southerly aspect (135° to 225°).
- The wind speed at 30 m has to be above 5 m per second.

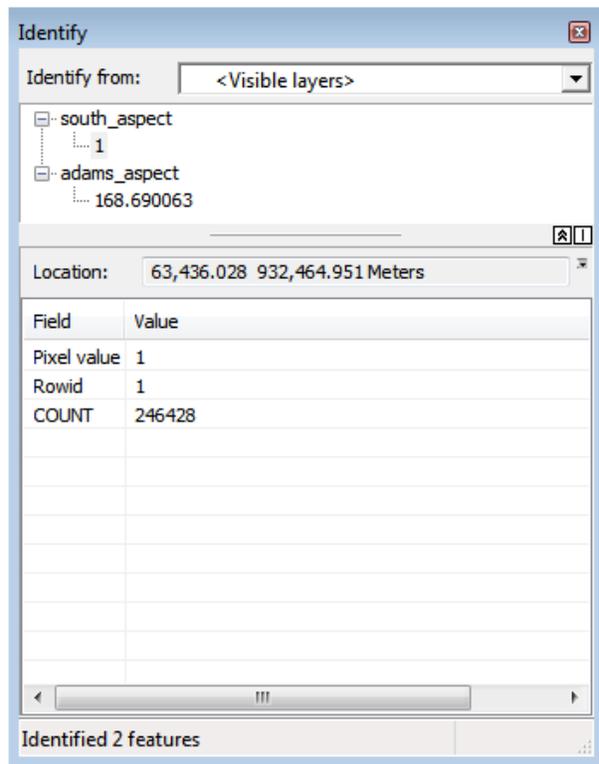
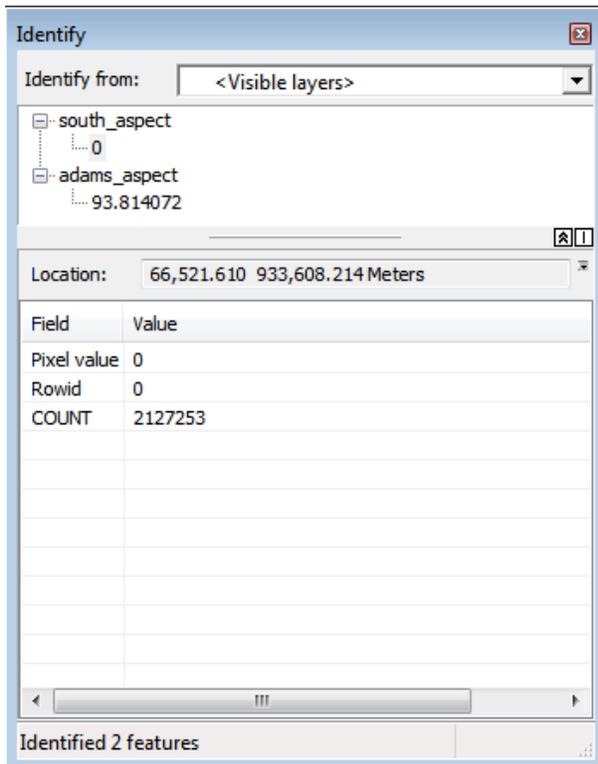
You combine all three criteria into one long Raster Calculator expression or create three binary grids (one for each criterion) and add them up – any cell with a value of 3 would match all our criteria.

1. You start with two original grids: DEM and wind
2. You calculate two derived grids: slope and aspect
3. Then you create several logical grids along the way = raster calculator output grids. These grids are temporary or ‘scratch’ grids because, at the end, you do not need them! Or you perform the selection in one single Raster Calculator expression.
4. You finish with one final grid!



***Whatever you do: test and confirm that your selection yielded the expected results!***

1. Change the color of the zero grid value to transparent and overlay onto the DEM. For example, your southerly aspect grid cells should look reasonable given the topography. For Adams, we see south-facing grid cells associated with stream valleys.
2. Overlay onto a topographic map, satellite image, etc. from ArcGIS Online. You can set the transparency of your entire southerly aspect grid to 'see through' the grid onto the underlying contour lines.
3. Use the Identify Tool and click around. Make sure only your aspect grid and southerly aspect grid are visible and set the Identify Tool to identify from all visible layers. When you click on a grid cell with a value = 1, the underlying aspect grid should be between 135° and 225°. Conversely, you click on a grid cell with a value = 0, the underlying aspect grid should show values NOT be between 135° and 225°.



Getting the details correct can be frustrating...but ultimately that's just a matter of figuring-out the logical expression (= algebra!) and the tools.

***More interesting: now what?***

- What is on that land?  
Lakes, wetlands, national parks, nuclear power plants, endangered species, etc.
- Ownership and regulation (e.g. zoning, hazardous waste site, etc.)
- Wind: perhaps there are many more suitable areas if we lower the wind speed requirements down to 4 m per second?

➔ Show your site selection as Tier 1 sites (>5 m/s) and Tier 2 sites (4 to 5 m/s) in different colors.

## **1.1) Grid Size Issues**

This is an issue you run into all the time: you need to perform raster calculations on grids with different grid sizes. Here:

- The DEM and its derived grids (e.g. slope, aspect, etc.) are 5 m by 5 m.
- The wind speed is 200 m by 200 m (i.e. 160 times coarser!).

For example, you use Raster Calculator to find the locations that are above 500 m in elevation (using the DEM grid) and have wind speeds greater than 5 m/s (using the wind grid). So...what happens if one of the 160 DEM grid cells inside one of the wind grid cells satisfies this query, but 159 do not?

Here's what happens in Raster Calculator when using different-sized grids:

<http://forums.esri.com/Thread.asp?c=93&f=982&t=107393>

### **Solutions!**

- Define the cell size used by Raster Calculator so you know how your Boolean algebra is executed.
- Make one grid more detailed (Resample tool) or one grid more generalized (Aggregate tool).

### **Take-Home Message:**

- Know your data!
- Don't assume anything!
- Test your methods!
- Keep your map organized (rename layer, use group layers, etc.)

## 1.2) ArcGIS to Google Earth

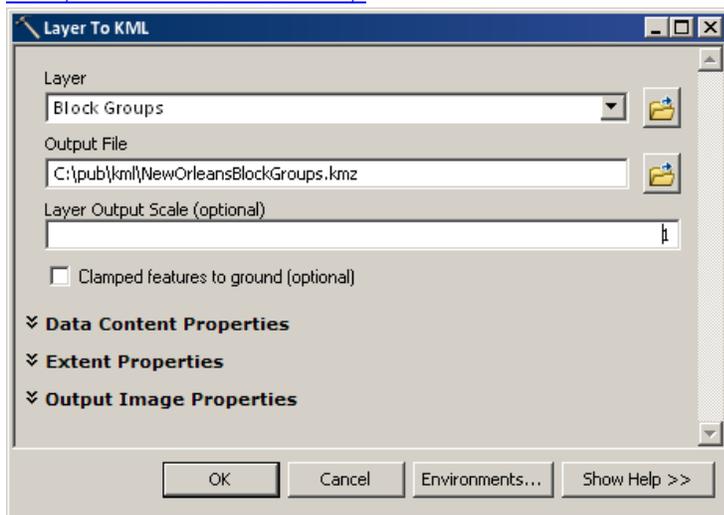
It is very easy to convert layers or maps from ArcGIS to KML/LMZ – the language of Google Earth.

### Creating KML in ArcGIS for Desktop

[http://resources.arcgis.com/en/help/main/10.1/index.html#/Creating\\_KML\\_in\\_ArcGIS\\_for\\_Desktop/00s200000009000000/](http://resources.arcgis.com/en/help/main/10.1/index.html#/Creating_KML_in_ArcGIS_for_Desktop/00s200000009000000/)

### Layer to KML

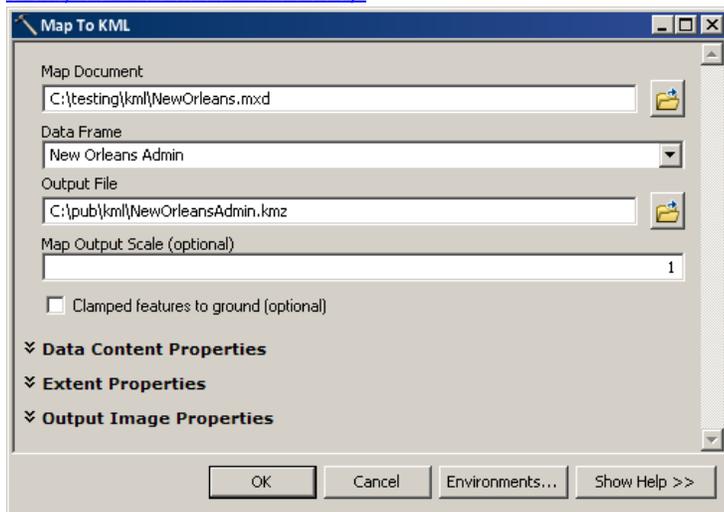
[http://resources.arcgis.com/en/help/main/10.1/index.html#/An\\_overview\\_of\\_the\\_To\\_KML\\_to\\_olset/00120000002n000000/](http://resources.arcgis.com/en/help/main/10.1/index.html#/An_overview_of_the_To_KML_to_olset/00120000002n000000/)



*Be sure to explore the tool options!*

### Map to KML

[http://resources.arcgis.com/en/help/main/10.1/index.html#/An\\_overview\\_of\\_the\\_To\\_KML\\_to\\_olset/00120000002n000000/](http://resources.arcgis.com/en/help/main/10.1/index.html#/An_overview_of_the_To_KML_to_olset/00120000002n000000/)



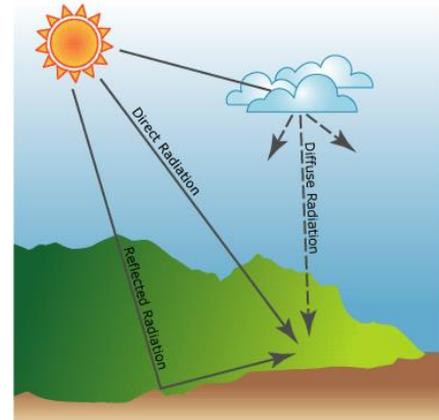
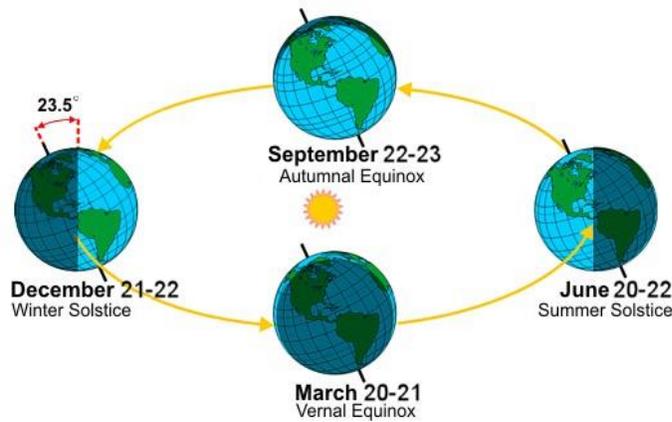
## 2) Solar Radiation Modeling

**Insolation = what arrives at the top of the atmosphere**

Easy to calculate, depends on the tilted orbit of the Earth and the solar constant.

**Global Radiation (GR) = what finally arrives at the Earth's surface**

GR = Direct Radiation + Diffuse Radiation + Reflected Radiation



Insolation is modified as it travels through the atmosphere; is further modified by topography and surface features; and is intercepted at the earth's surface as direct, diffuse, and reflected components. Direct radiation is intercepted unimpeded in a direct line from the sun. Diffuse radiation is scattered by atmospheric constituents, such as clouds and dust. Reflected radiation is reflected from surface features. The sum of the direct, diffuse, and reflected radiation is called total or global solar radiation.

Generally, direct radiation is the largest component of total radiation, and diffuse radiation is the second largest component. Reflected radiation generally constitutes only a small proportion of total radiation, except for locations surrounded by highly reflective surfaces such as snow cover. The solar radiation tools in ArcGIS Spatial Analyst do not include reflected radiation in the calculation of total radiation. Therefore, the total radiation is calculated as the sum of the direct and diffuse radiation.

**→ Global Radiation depends on insolation, scattering/absorption/transmission in the atmosphere, elevation, slope, aspect, shading, and surface reflectivity.**

All these parameters can be easily calculated using basic astronomy, basic geography, basic trigonometry, and basic climatology.

Elevation, slope, aspect, shading	DEM
Insolation	Calculated by an orbital insolation model
Atmospheric Effects	Calculated by an atmospheric transmission model
Surface Reflectivity	Ignored in ArcGIS

### **3) Homework for Wednesday**

On Wednesday we will use the various solar radiation tools in Spatial Analyst to model solar radiation for a new solar farm. To get started:

**1) Read:** An overview of the Solar Radiation tools

[http://resources.arcgis.com/en/help/main/10.1/index.html#/An\\_overview\\_of\\_the\\_Solar\\_Radiation\\_tools/009z000000t4000000/](http://resources.arcgis.com/en/help/main/10.1/index.html#/An_overview_of_the_Solar_Radiation_tools/009z000000t4000000/)

**2) Read:** Locating Sites for Photovoltaic Solar Panels

This is a great case study that we could easily do locally – note how they used ModelBuilder to organize their analysis.

<http://www.esri.com/news/arcuser/1010/files/solarsiting.pdf>

**3) Watch:** Introduction to ArcGIS Spatial Analyst

This is a great video about everything that Spatial Analyst has to offer. It is worth watching the entire video at 72 minutes, but here are some especially interesting sections.

Minute 7:30	Cell sizes
Minute 39:55	Surface Analysis
Minute 41:10	Solar Radiation Tools

<http://video.esri.com/watch/1953/introduction-to-arcgis-spatial-analyst>

**4) Write:** Create a conceptual flowchart of how you would conduct a solar potential analysis for Westfield (MA), using the case study for Tucson (AZ) as a starting point. Consider your data needs, the geoprocessing tools required, and the appropriate sequence of analysis steps.

- Page 1: cover page
- Page 2: conceptual flowchart
- Page 3: table with data layers
- Page 4: table with geoprocessing tools

I expect professional work – as always ask yourself: can I take this work to a job interview to demonstrate that they should hire me? If the answer is no...it's not good enough.