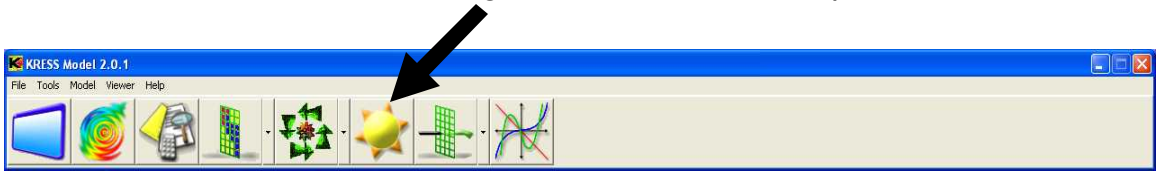
Insolation Modeler

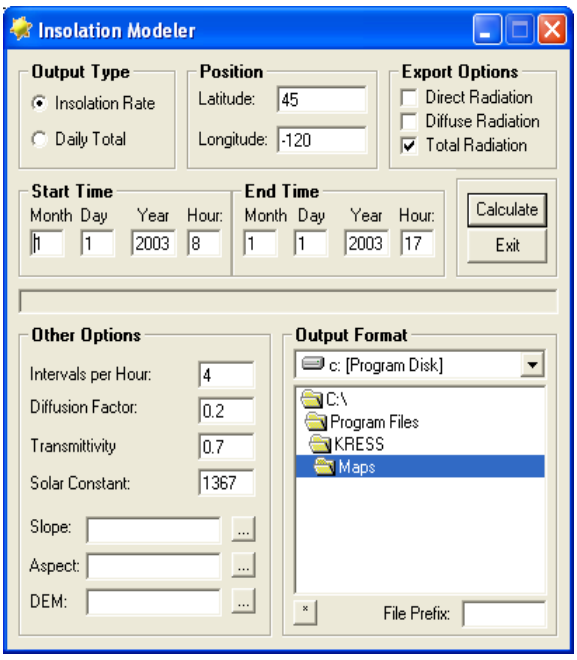
The Insolation Modeler can be accessed by clicking Insolation Modeler under the **Tools** menu, or by clicking the **Insolation Modeler** Button. This program allows the user to estimate incoming solar radiation by taking into account the orbit and tilt of the earth, the contour of the ground, and basic atmospheric conditions.



The user must first load their DEM, slope, and aspect files. Slope and aspect files can be generated in the Generate Slope and Aspect Files from DEM form. The Position fields (Latitude and Longitude) can be automatically filled when the DEM, slope and aspect files are loaded.

The Insolation Modeler Requires That Slope Be Calculated In Degrees.

Next, the user must designate how many intervals per hour are being calculated. If the user is interested in daily totals, then this is important only for accuracy, but if the user wants an output of insolation rates, then every interval will export a file, so the number of intervals per hour becomes important. In either case, the more intervals per hour, the more accurate the estimation is, but the longer the Insolation Modeler will take to process all the information. The user can enter the desired intervals per hour in the textbox labeled Intervals per Hour.



Next, the user must enter values for the **Atmospheric Diffusion Factor**, **Atmospheric Transmittivity**, and **Solar Constant** in the textboxes next to the appropriate label. The transmittivity is the percentage of light that strikes the ground without being diffused or reflected, in other words, the light that reaches the ground in a direct path. This can be as high as .7 or as low as .3 depending on the atmospheric conditions including humidity, cloud cover, and amount of particles in the air. The diffusion factor is the percentage of light that reaches the ground after being diffused through the atmosphere, or the light that reaches the ground in any way but a direct path. This can be as low as .2 on a sunny day, and as high as .6 on a cloudy day. This number added to the transmittivity cannot exceed 1, and is usually not greater than .9 since some light is reflected back into space.

The **Solar Constant** is the amount of radiation that reaches Earth's outer atmosphere. The general approximation is 1367 $W \cdot m^{-2}$, but if the user has more accurate numbers, they have the option of altering this constant.

Next, the user must input a start time and end time using 24 hour time notation for the hours. The output type must be selected using the option buttons in the upper left corner of the form. **Insolation per Hour** will export a file for every interval calculated, giving the user the rate of insolation for every cell in the DEM in $W \cdot m^{-2}$.

Daily Totals will write a file for every day calculated with the total insolation received over the course of an entire day for each cell in the DEM. Units for daily totals are in $Joules \cdot m^{-2}$.

The way the program calculates the insolation (or radiation from the sun) is by a process of steps to determine the position of the sun, the angle of the horizon for each location on the ground (cell in the DEM) in the relevant direction, the effect of atmospheric conditions, length of the atmospheric path, and angle of incidence of direct sunlight with the ground.

The position of the sun is calculated using standard equations taking into account the rotation of the earth around the sun, the tilt of the earth on its axis, and the time of day, calculated with corrections to local time for distance from the local standard time meridian. The position of the sun is calculated for every interval the program is run.

The program calculates horizon angles for every point on the DEM in eight directions, or every 45 degrees. The program interpolates between these eight directions so that the horizon angle of any direction can be estimated. Then, using the position of the sun, the program will reference the appropriate angle to

see if the sun is in a direct line of sight for the point on the ground. This is tells the program if the area is in shadow or direct sunlight.

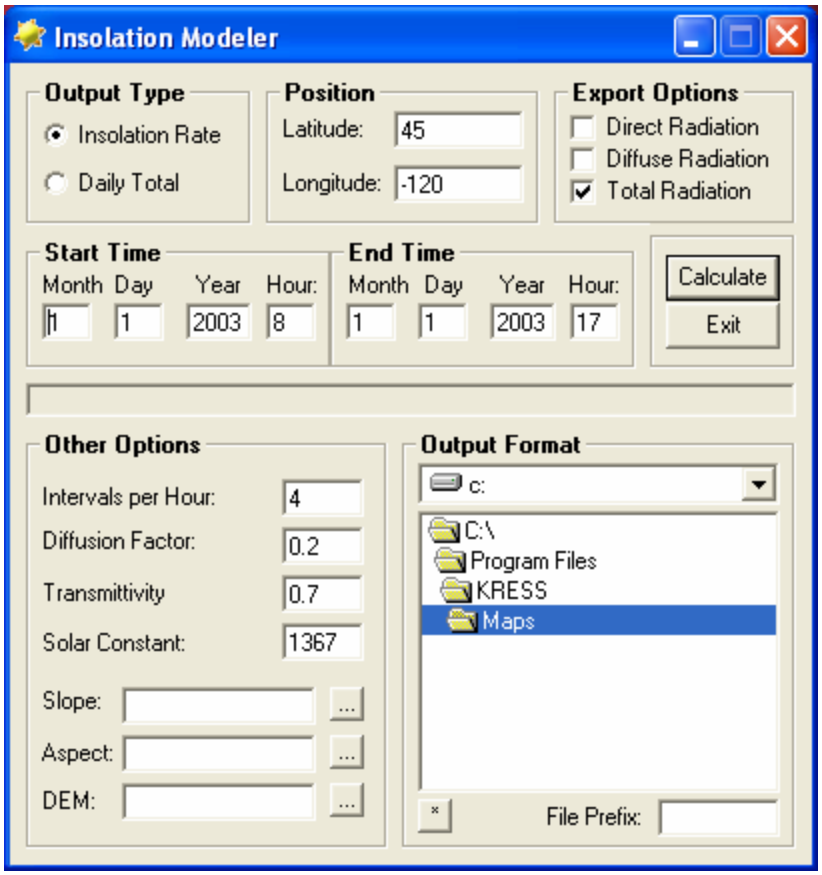
The user can choose export options as well. **Direct Radiation** gives the amount of radiation represented by light that strikes the earth traveling in a straight path. This is approximately represented by the transmittivity factor. The **Diffuse Radiation** is the radiation coming from anything but a straight path. This is approximately represented by the diffusion factor. **Total Radiation** gives the sum of the diffuse and direct radiation calculations, accounting for all the incoming solar radiation.

The **Insolation Modeler** will use the transmittivity and diffusion factors specified by the user to calculate how much the light is affected by the atmosphere. It also takes into account how much of the atmosphere the light is traveling through since the sun directly overhead passes through less atmosphere than the sun just over the horizon.

Lastly, the program takes into account the angle of incidence of the direct sunlight for each cell in the DEM by using the slope and aspect files and the position of the sun. The angle of incidence affects the intensity of the light hitting the ground.

The user can specify an output directory and prefix for the files to be generated in. When the files are written, an information text document will also be written to provide the user with all the data supplied in running the program as well as a list of all the filenames with their corresponding time interval. The Calculate button will start the program. This program will take a long time to run, especially with a large DEM (1000 by 1000 cells or larger). So it is best to let the program run overnight.

It should be noted that the program does not take the curvature of the earth into account within a data set and very large DEMs (those covering hundreds or thousands of square kilometers) may have significant differences between the eastern most and western most positions. This is usually only a significant problem with calculation of **Insolation Rate** and not **Daily Total Insolation**.


Insolation Modeler
Output Type
Insolation Rate
Daily Total
Position
Latitude: 45
Longitude: -120
Export Options
Direct Radiation
Diffuse Radiation
Total Radiation
Start Time
Month Day Year Hour:
1 1 2003 8
End Time
Month Day Year Hour:
1 1 2003 17
Calculate
Exit
Other Options
Intervals per Hour: 4
Diffusion Factor: 0.2
Transmittivity 0.7
Solar Constant: 1367
Slope:
Aspect:
DEM:
Output Format
c:
C:\
Program Files
KRESS
Maps
File Prefix: