User Interface: Simple Model of Atmospheric Radiative Transfer of Sunshine

WINDOWS Version 2.9.5.i1.3

September 2008

Introduction

This document provides instructions for installing and running the User Interface for the *Simple Model of Atmospheric Radiative Transfer of Sunshine* (SMARTS). The SMARTS code is a stand-alone executable Fortran program requiring an ASCII text input configuration file. The User Interface documented here assists the user in creating the model input configuration file. Once a configuration file is completed, the model may either be run from the interface or from the system command line.

> *Note: The model, its input file, and resulting output are fully documented in the "SMARTS, User's Manual", available in pdf format from this package. The User's Manual is the primary and definitive source of information about the model. Information in that document will not be duplicated in these instructions except as necessary to explain Interface operation.*

Hardware and Software Requirements

A 200MHz computer is recommended with about 5 MB free drive space. Your monitor's resolution should be set to at least 800 x 600 pixels. Microsoft Excel, version 97 or later, is required to run this User Interface. If Microsoft Excel is not installed on your computer, you can still run the SMARTS code but you need to prepare its input file manually, by precisely following instructions in the User's Manual.

Windows version 98 or later is recommended. (This preliminary version of the Interface has been tested on Windows 98, Windows 2000, and Windows XP. Compatibility with other versions of Windows is not known.)

Installing the User Interface

The User Interface is contained in a file named SMARTS295.XLS. To install:

- Create a folder with a name of your choice. This folder will be referenced in these instructions as the *SMARTS2 folder* regardless of the name you choose.
- Copy all files from the distribution disk to the SMARTS2 folder (the installation will create an additional folder called *INPUTS* beneath the *SMARTS2* folder).

> ***Important**: If copying from a CD, the files will be copied to your hard drive as read-only, which may cause execution failure of the interface. Use Windows Explorer to remove the read-only attribute on all files:*
>
> - *Right click the file name(s) and select Properties from the popup menu*
> - *Near the bottom of the Properties dialog box, clear the check mark from the Read-only attribute*
> - *Click the Okay button*

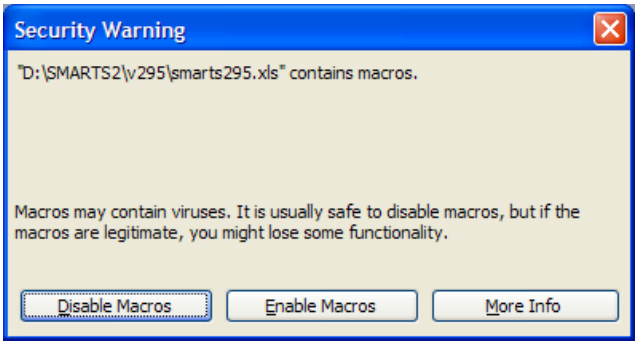
Running the User Interface

Start the User Interface from within Microsoft Excel.

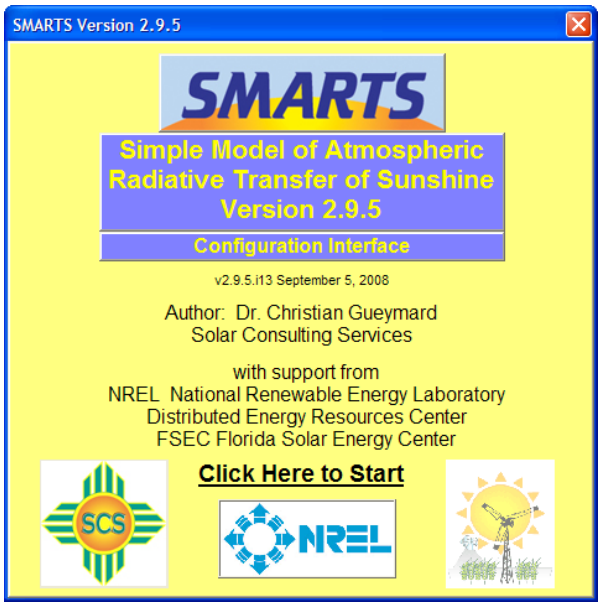
***Important**: The User Interface must always be started by opening it as a spreadsheet from within Microsoft Excel as described below. Other methods of starting the Interface (such as double-clicking its file icon) may result in improper operation.*

- Using the Windows start menu or a desktop shortcut, start Microsoft Excel
- From the Excel File pulldown menu, choose Open
- Using the Open file browsing window, navigate to the SMARTS2 folder
- From the file list, select the SMARTS2 Excel spreadsheet file. Either double-click the file or click the Open button.

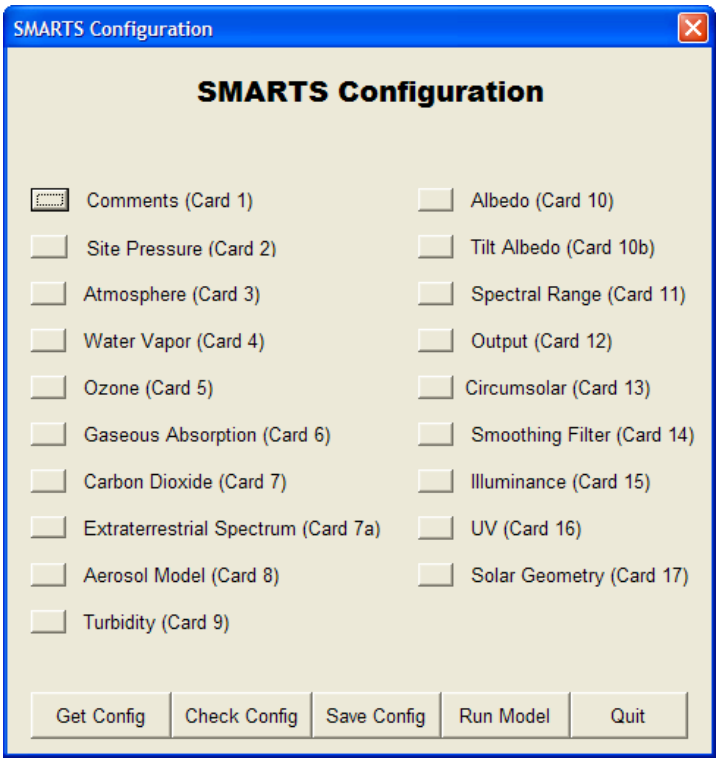
The SMARTS295 spreadsheet contains macros. If your Excel program is configured to issue warnings about macros, you will see the following (or similar) warning screen. **You must click *Enable Macros* to run the interface.**



When the interface starts, you will see the following startup window. Start the User Interface by clicking on the *Click Here to Start* message.



After the startup screen, you are presented with an overview window that provides access to all configuration parameters in the SMARTS input file:



Each small button on the window corresponds to a **Main Card**, as documented in the User's Manual. The Optional Cards referenced in the User's Manual do not have a similar counterpart in the User Interface. Depending on your configuration, the Optional Cards are created as necessary by the User Interface and written to the configuration file.

Five action buttons are located at the bottom of the configuration window:

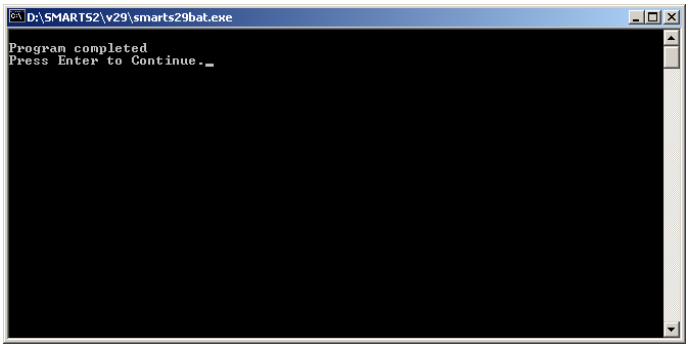
Get Config: This allows you to retrieve a previously configured input file by using a conventional Windows file browser. The default folder for input files is the *INPUTS* folder, located beneath the *SMARTS2* folder. However, input files may be retrieved from any location.

Check Config: This option will perform fundamental validity checks of your configuration. Many cards have interdependencies that, if improperly configured, could cause erroneous results or model execution failure. In addition, this option will alert you to several conflicting configurations that force an input override, which may create model input that you had not intended.

Save Config: This allows you to save a configuration with a unique file name. The default folder for input files is the *INPUTS* folder, located beneath the *SMARTS2* folder. However, input files may be saved in any location.

> ***Important****: You should not save a configuration to the name* SMARTS295_INP.txt *in the* SMARTS2 *folder, as this is the file used by the interface to run the model. If you do so, your file may be overwritten by the interface.*

Run Model: This calls the Fortran executable code and produces the output file(s). The output file(s) is named SMARTS2 with the appropriate extension(s). The interface opens a command window to display the model execution. When the model completes execution, you see the following:

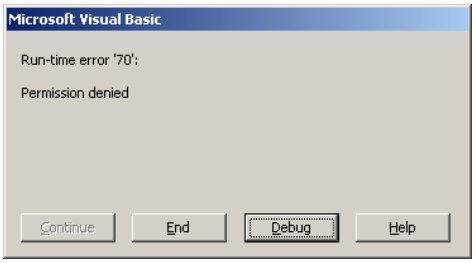


To return to the Interface, press the *Enter* key.

> ***Important****: The model always creates files with the SMARTS295_xxx.txt) name. You must rename them prior to any subsequent model runs.*

The current version of the User Interface does not have the capability of viewing the model output. Output results are available from at least one file (SMARTS295_OUT.txt) that recapitulates the input data, and provides intermediate results as well as broadband irradiances. Two optional spreadsheet-ready spectral files (SMARTS295_EXT.txt and SMARTS295_SCN.txt) are also present if spectral results are requested. An ASCII text editor, such as the Windows utilities NotePad or WordPad, may be used to view any of these three files. Alternatively, the two output spectral files may be imported into Microsoft Excel or other analytical/statistical tool for plotting, etc.

***Important**: If another program, such as an editor or spreadsheet, is using an output file, the system may consider the file locked and unavailable for the interface. If you attempt to run the model under such conditions, you may encounter irrecoverable errors such as the one shown. Close the competing program and restart the Interface.*



Quit: This closes the User Interface (but does not unload it from Excel). A restart option appears in the upper left corner of the Excel spreadsheet. Click the Restart button if you wish to the User Interface again. Exit Excel in the usual manner.

***Important**: When exiting, Excel will ask if you want to save changes to SMARTS295.XLS. It is **not** necessary to save the changes. However, you should be aware that electing to save the spreadsheet will save the current configuration as the default when the Interface is reloaded and run in the future.*

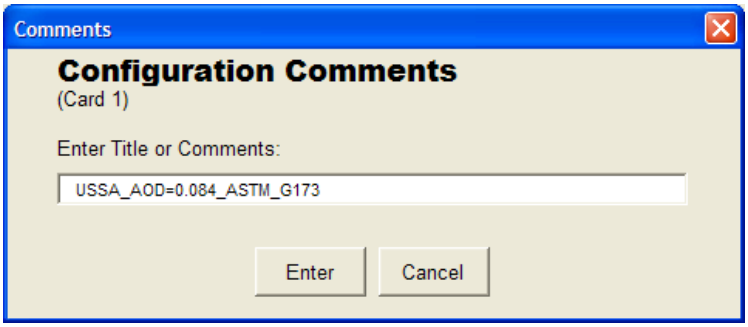
Input Configuration

Clicking any of the card configuration buttons will present a window with appropriate input selections and options for that card. In all cases, you may press an *Enter* button when your configuration is complete, or press a *Cancel* button to leave the configuration unchanged. When the *Enter* button is pressed, a validity check is performed on all input data. Any invalid entries are presented in an error box, and you must correct any errors before the card configuration is saved. The User Interface is supplied with a default configuration that provides valid startup values for most fields.

In many cases during configuration, you may find that data entry fields are locked out, preventing data entry. This occurs when those inputs are inappropriate for a given configuration.

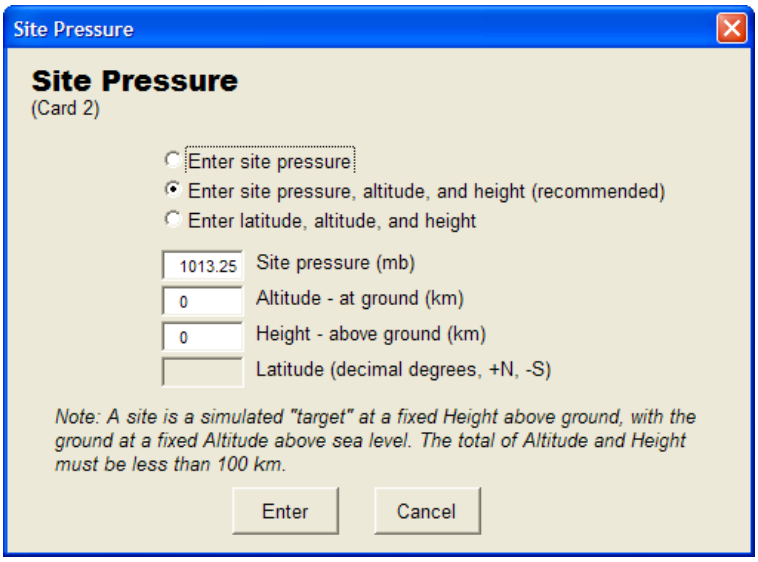
Each card configuration window is described below.

Comments (Card 1)



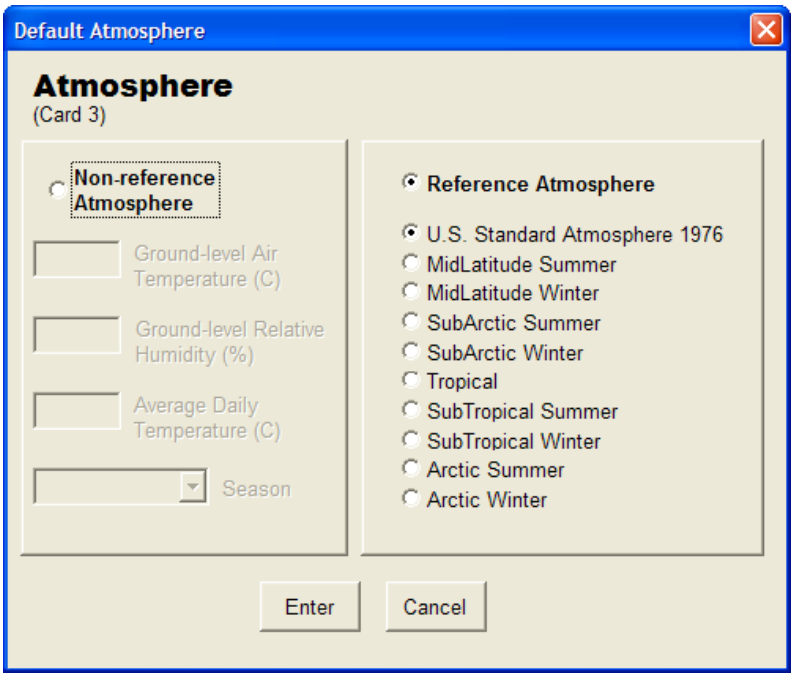
You may enter text up to 64 characters long.

Site Pressure (Card 2)



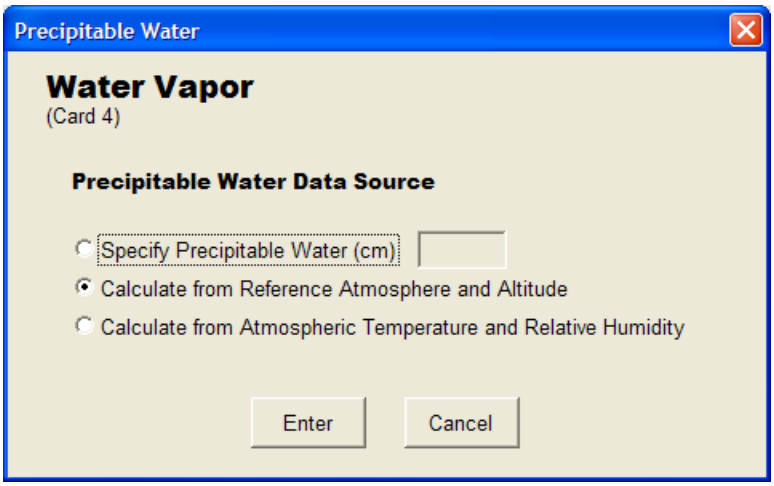
Parameters for either specifying or calculating site pressure are entered on this card. The site may be either at ground level or elevated above the ground (such as on a tower or aircraft). *Altitude* refers to ground level above mean sea level, and *Height* refers to the distance above the ground. *Site Pressure* is always that of the site, which is at a total elevation of Altitude + Height.

Default Atmosphere (Card 3)



You may either enter specific atmospheric conditions or select a reference atmosphere.

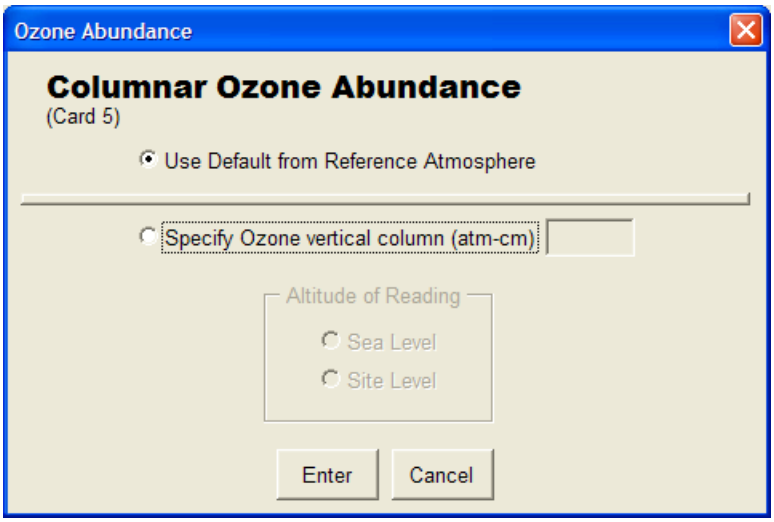
Water Vapor (Card 4)



You may enter a specific value for water vapor or calculate it from other parameters.
Note these interdependencies:

- If you choose the second option and you did not select a reference atmosphere on Card 3, precipitable water is calculated using the U.S. Standard Atmosphere.
- Choosing the third option is possible, but not recommended, when you select a reference atmosphere on Card 3.

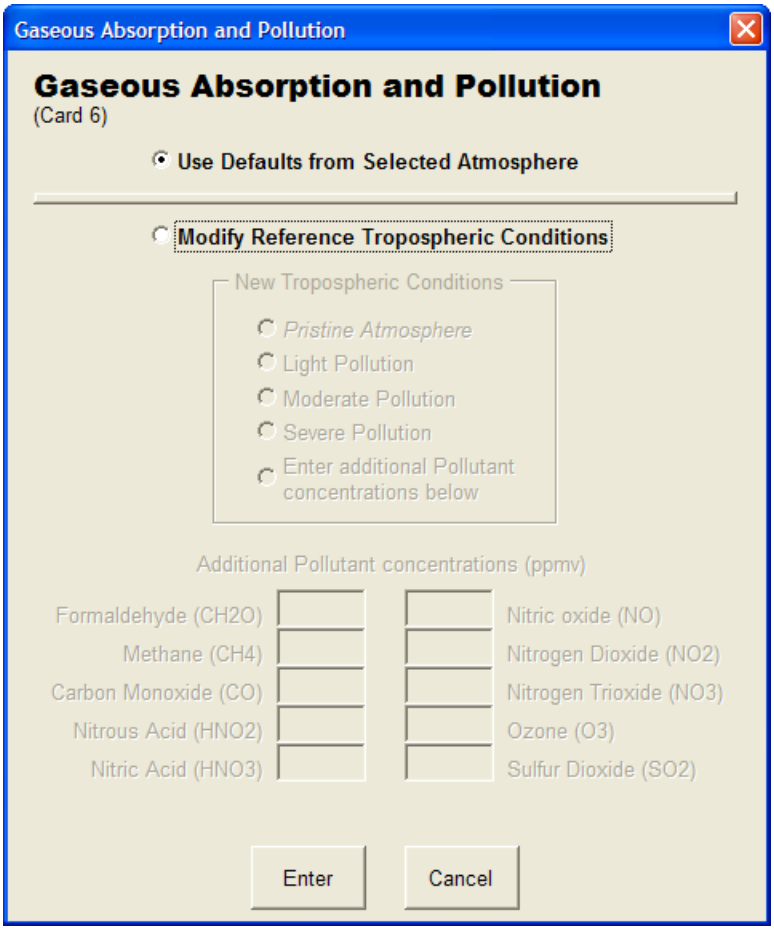
Ozone (Card 5)



You may elect to either use the ozone abundance from the reference atmosphere or enter a value. If you enter a value, you must specify whether it is a *sea level* or *site level* value. The sea-level ozone value is corrected at run time for the site's altitude. No correction is done when selecting the site-level option.
Note this interdependency:

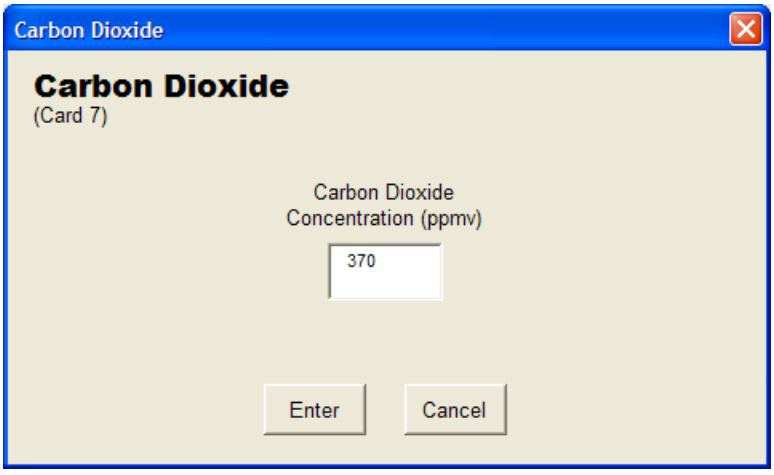
- If you choose the first option, it is recommended you select a reference atmosphere on Card 3. Otherwise, the ozone value will be defaulted to that for the U.S. Standard Atmosphere.

Gaseous Absorption and Pollution (Card 6)



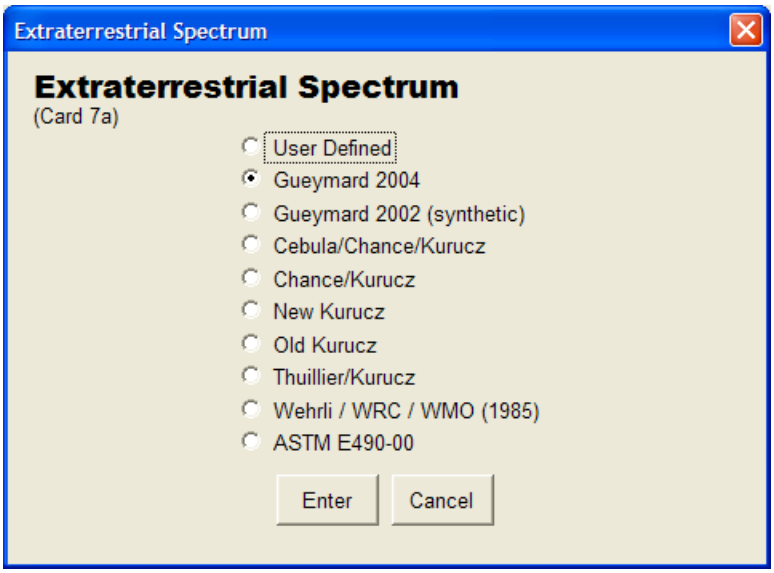
You have a choice of using default tropospheric concentration values for pollution-related gases corresponding to your specific atmospheric conditions or modifying these defaults. If you choose the latter option, you have the additional choices of four pre-defined pollution characteristics or the possibility of entering concentration levels of ten specific pollutants. These concentrations must correspond to an assumed 1-km homogeneous pollution layer above ground. See User's Manual for more details.

Carbon Dioxide (Card 7)



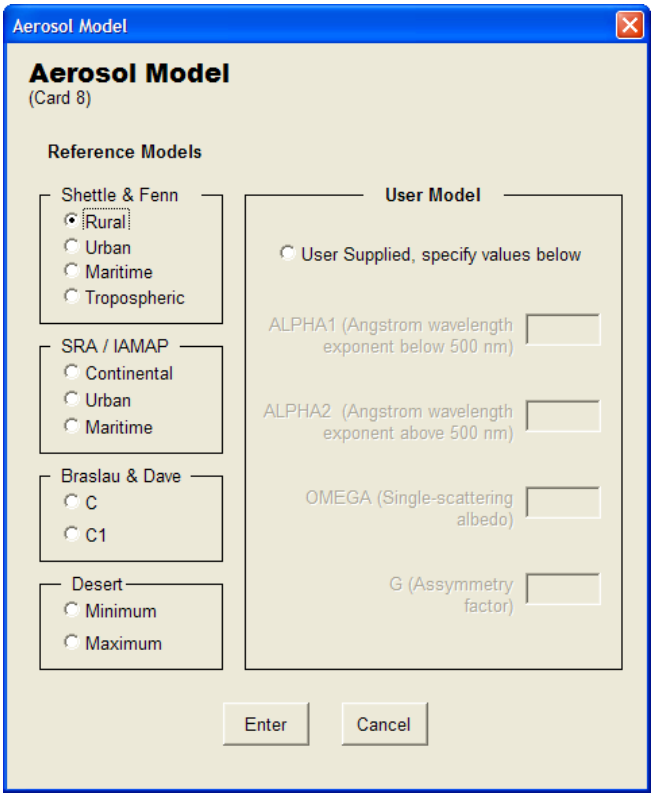
Enter the carbon dioxide concentration. It does not depend appreciably on the altitude of the site, but slightly rather on season, location and year (greenhouse effect…)

Extraterrestrial Spectrum (Card 7a)



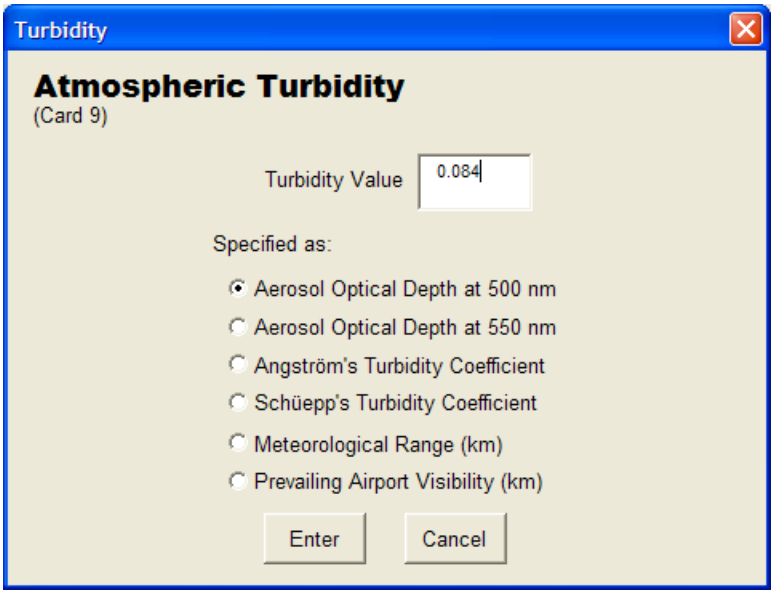
Select from among the ten models of extraterrestrial spectrum.

Aerosol Model (Card 8)



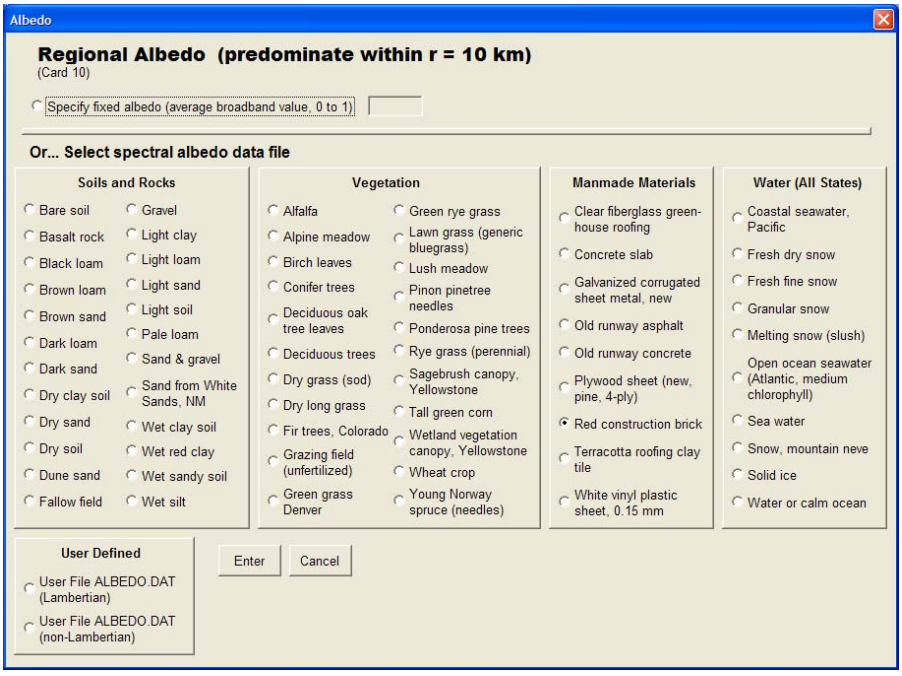
Choose from among the eleven reference models, or choose the *User Supplied* model and enter the required parameters.

Atmospheric Turbidity (Card 9)



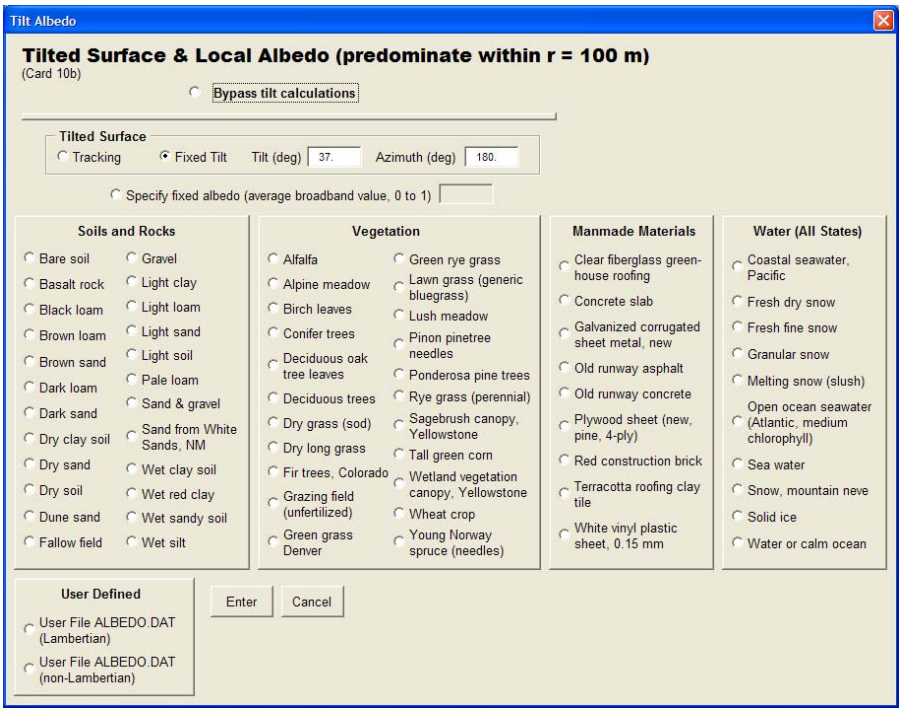
Select the desired turbidity parameter and enter its value in the input field.

Albedo (Card 10)



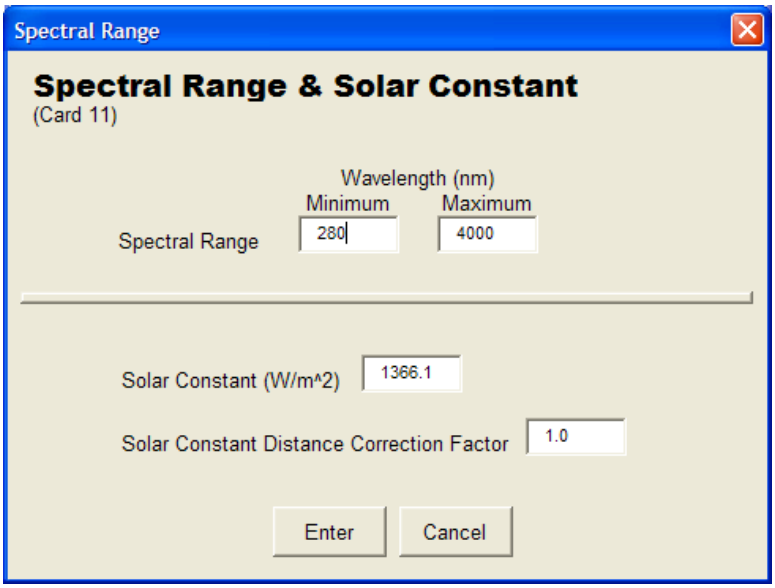
You may specify a fixed albedo or choose from pre-defined spectral albedo files. Note that these files result from experimental measurements and rarely cover the whole shortwave spectrum. Use of a user-supplied spectral file (ALBEDO.DAT) is another option.

Tilted Surface and Local Albedo (Card 10b)



You may choose to bypass tilt calculations or specify a *Tracking* or *Fixed Tilt* along with albedo designations. The library of spectral files for Card 10b is identical to that for Card 10.

Spectral Range and Solar Constant (Card 11)

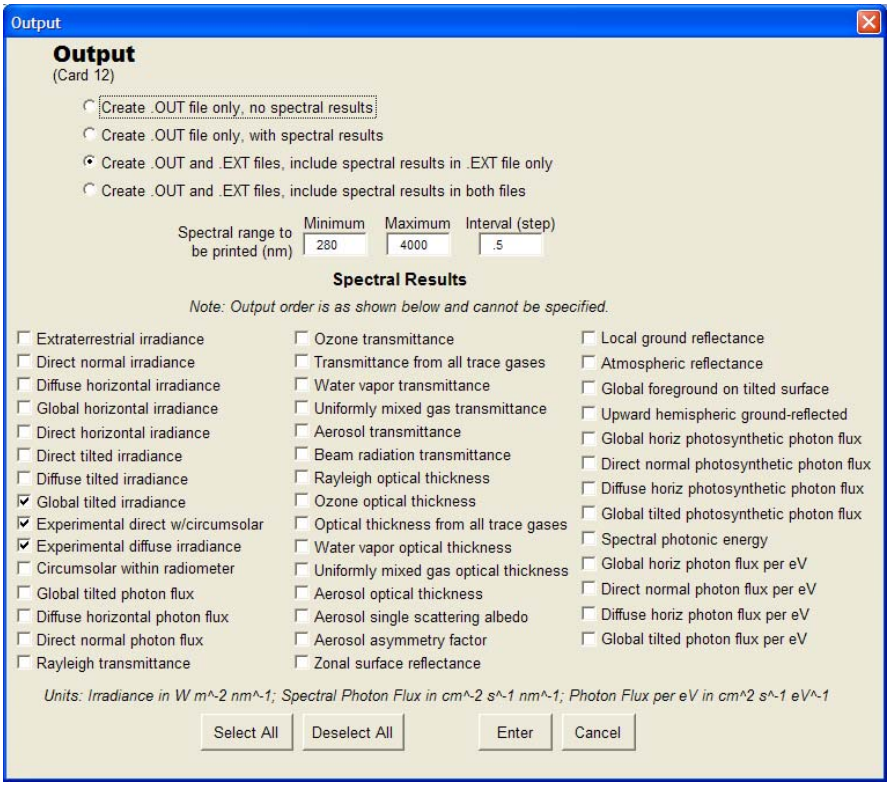


Enter the range between which all spectral calculations will be performed, the desired value for the solar constant, and the distance correction factor. The largest possible spectral range is 280 to 4000 nm. The distance correction factor should be 1.0 for the average sun-earth distance.

Note these interdependencies:

- The minimum and maximum wavelength values must include the range on Card 12
- A choice of the fourth option on Card 17 (Year, Month, Day, etc.) will calculate an accurate distance correction factor that overrides the value on this card.

Output (Card 12)

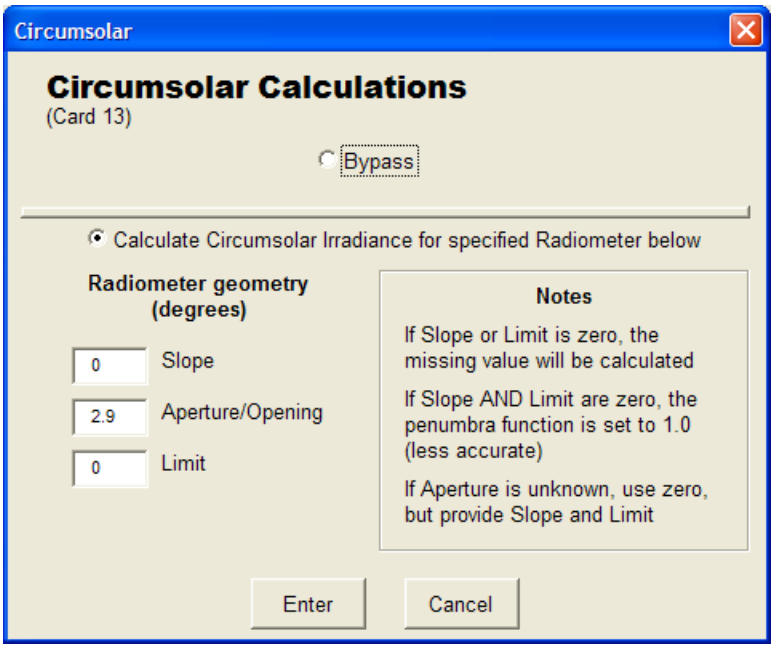


Select the desired output configuration. If spectral results are selected, the interval (printing step) must be at least 0.5 nm. Furthermore, the output order will be in the same order as displayed in the window (top to bottom, then left to right). You may select all configurations with the *Select All* button, or deselect all of them with the *Deselect All* button.

Note this interdependency:

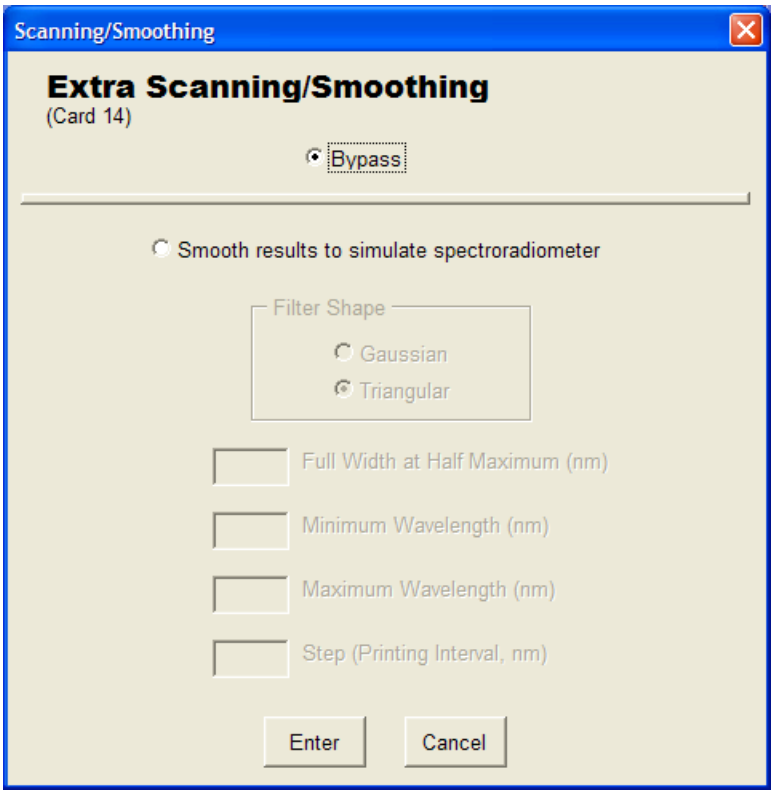
- The minimum and maximum wavelengths must fall within those specified on Card 11.

Circumsolar Calculations (Card 13)



You may choose to bypass these calculations or enter specifications for a particular radiometer. Slope or limit angles will be calculated if set to zero. If both are zero, the penumbra function is set to 1.0, resulting in a less accurate calculation. If the aperture is unknown, set it to zero and it will be calculated from the other two values.

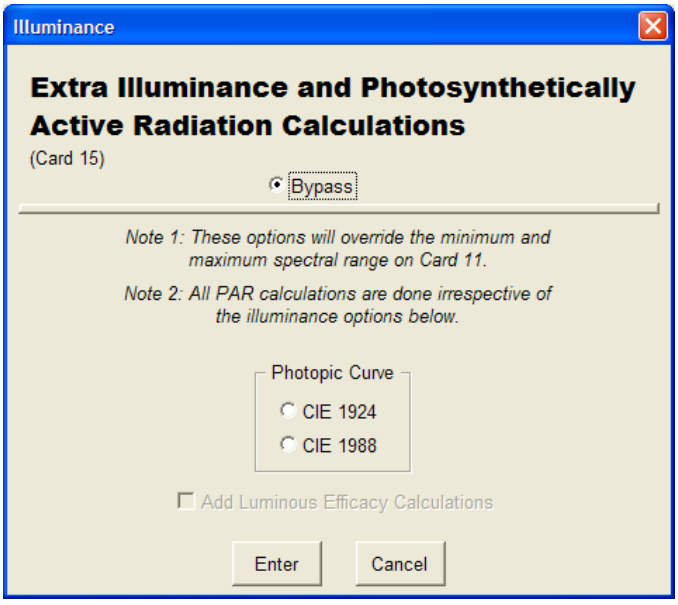
Filter (Card 14)



You may choose to bypass the scanning/smoothing function, or enter parameters to simulate a spectroradiometer. These calculations are in addition to the basic model's calculations. Therefore, if the scanning/smoothing option is selected here and spectral results are requested on Card 12, you will obtain two different sets of spectral results in separate files.
Note these interdependencies:

- The range (maximum minus minimum) must be at least twice the full width at half maximum (FWHM) value
- The minimum wavelength must be greater than the FWHM value plus the minimum specified on Card 12
- The maximum wavelength must be less than the maximum specified on Card 12 minus the FWHM value.

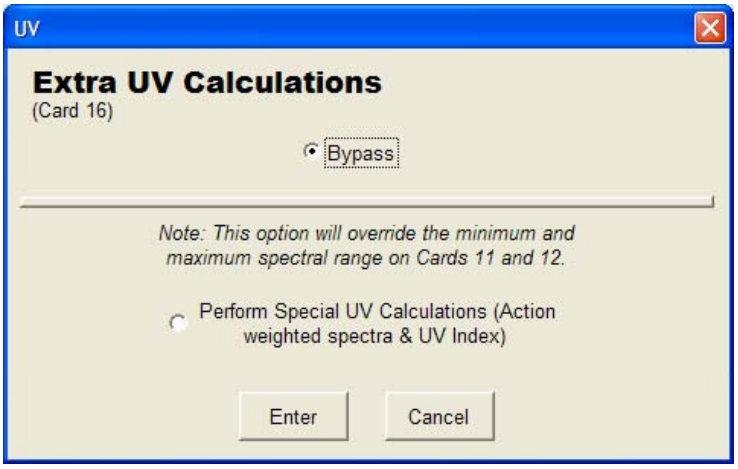
Illuminance (Card 15)



You may choose to bypass these calculations or use a photopic curve for extra illuminance calculations. If specifying a curve, you have the additional option of adding luminous efficacy calculations.
Note these interdependencies:

- Specifying a curve will override the minimum and maximum wavelength entered on Card 11, if necessary, to cover at least the range from 359 to 830 nm.
- Adding luminous efficacy calculations will also override the specified range on Card 11, to cover the largest possible range, 280–4000 nm.

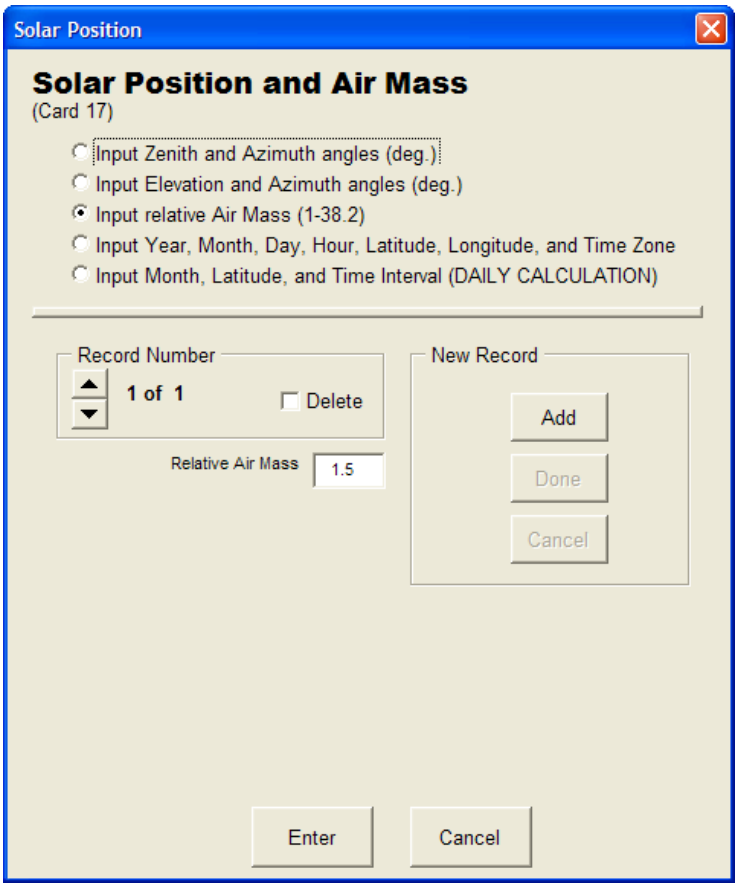
Extra UV Calculations (Card 16)



Select to either bypass or perform special action weighted spectra calculations.
Note this interdependency:

- Choosing the special calculations will override the minimum and maximum spectral range entered on Card 11 to cover at least the whole UV spectral range (280–400 nm).

Solar Position and Air Mass (Card 17)



You may choose from among five configurations for calculating solar position and air mass. Each configuration presents appropriate input fields (only one sample configuration is shown here, for the third possible configuration). Multiple (up to 1000) records may be configured and will produce as many outputs from a *single* run of the code. Note that only records of one configuration type may be entered, and that they will all use the same common atmospheric conditions. Changing the input configuration will remove all existing records (a warning will be issued before the records are deleted).

Inputs for zenith and elevation angles are the refraction-corrected (apparent) angle. These angles are accurately calculated when specifying the date (fourth configuration).

Important: When using the last option (for a daily calculation), the *Time Step Interval* value needs to be carefully chosen. It must be a divisor of 60 (e.g., 5, 6, 7.5...). There is a trade-off between choosing a lower number for accuracy and a larger number to decrease computation time. A time step of 5 to 10 minutes is recommended as the best compromise.

Note that the fourth configuration calculates the sun's position with very high accuracy. However, if the values entered correspond to nighttime, the User Interface cannot detect the problem. An error message will be issued at run time and will appear in the SMARTS295_OUT.txt file.

The interface allows you to scroll among existing records for viewing or editing, adding new records, or deleting records:

- To view and edit records, click the up and down scroll arrows in the *Record Number* box. To change the value of a record, click in the desired field and make the change.
- To add a new record, click the *Add* button. The fields of the new record default to those in the displayed record (thus, if you wish to create a new record similar to an existing record, scroll to the existing record before clicking the Add button). When the new record is complete, click the *Done* button in the *New Record* box. You may cancel the new record by clicking the *Cancel* button in the New Record box.
- To delete a record, select it using the up and down scroll arrows, then check the Delete box. The fields will be locked out (gray). The record is not actually removed until you exit the window by clicking the *Enter* button, but it will appear gray and the *Delete* box will be checked as you scroll to it. You may undelete the record by scrolling to it and unchecking the *Delete* box at any time before exiting the window.

Note these dependencies:

- Selecting the third option (Input Air Mass) does not completely define the sun's position. If tilted irradiance calculations are specified on Card 10b, this option should be avoided.
- Selecting the fourth option (Input Year, Month, Day, etc.) calculates a distance correction factor that overrides the value on Card 11.

Output

The minimum output consists of one file (SMARTS295_OUT.txt), which groups an echo of the input file, some intermediate results, and broadband irradiance results. Up to two additional output files (SMARTS295_EXT.txt and SMARTS295_SCN.txt) can be obtained, depending on the options selected on Cards 12 and 14. The latter files contain only spectral results and are in a spreadsheet-ready format.

Note that if more than one record is entered on Card 17, spectral results on files SMARTS295_EXT.txt and SMARTS295_SCN.txt will appear in succession along the same columns, as if only one record was entered—but with a separation header line between each block of result. For further analysis, it might become necessary to move these vertical blocks of results into new columns, from within your spreadsheet program.

> ***Important****: Before another run is attempted and you wish to save the current output, you need to either rename these output files or move them out of the SMARTS2 folder. Otherwise, execution of the model will overwrite the files.*

Known Interface Problems

1) The interface must be started by navigating to the SMARTS295.XLS and opening it from within Excel's file menu. If started using other shortcut methods (such as double-clicking the spreadsheet file in Windows Explorer), the interface will run, but the call to the Fortran model will fail.
2) The spreadsheet interface cannot be renamed from its distribution name (SMARTS295.XLS). Renaming the spreadsheet file will cause an interface runtime error.
3) Input configuration files must reside on the same *disk drive* as the SMARTS2 folder (but may be in a different folder). Selecting input files from another disk using *Get Config* will cause a runtime error when attempting to run the model.