

Guidelines for Post Processing ASD FieldSpec Pro and FieldSpec 3 Spectral Data Files using the FSF MS Excel Template

Version 03.1 (Feb 2009) By Peter Walker

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The NERC Field Spectroscopy Facility has created a number of Excel templates which can be used to post process the spectral data files from the ASD FieldSpec Pro and FieldSpec 3 spectroradiometers. The templates will allow multiple spectral data files to be compiled into a single spreadsheet, scaled for relative and absolute reflectance values or converted to spectral radiance or irradiance values. ASD spectral data files are saved in a binary format and must be converted to ASCII format using the ViewSpec Pro¹ program, before being processed by the FSF Excel template. **Note:** to ensure that the macros in the templates run correctly please close all other excel spreadsheets while you use the template.

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1. Using ViewSpec Pro to Convert ASD Binary Files to ASCII

The application ViewSpec Pro from ASD includes many useful features such as graphing, scaling, 1st derivative and conversion of the spectrometer's binary files into ASCII text files. For the purpose of this guideline we will only use the ASCII Export function. The application is installed on each of the facility's computers and is also available for the Analytical Spectral Device's website <ftp://ftp.asdi.com/Software/> contact FSF for further details.

- Start the ViewSpec Pro application.

Configuring ViewSpec Pro

The application can save the path/directory to your ASD spectrum files and the converted text files.

- From the Setup menu click on the **Input Directory** to select a New Directory Path to your ASD binary data files.



¹ ViewSpec Pro is installed on the FSF computers and is available from the Analytical Spectral Devices website

After selecting the default Input Directory you are offered the opportunity to make the **Output Directory** match the Input Directory. Alternatively, you can select a different path/directory using the Setup /Output Directory menu.

Open ASD Spectrum (Binary) Files

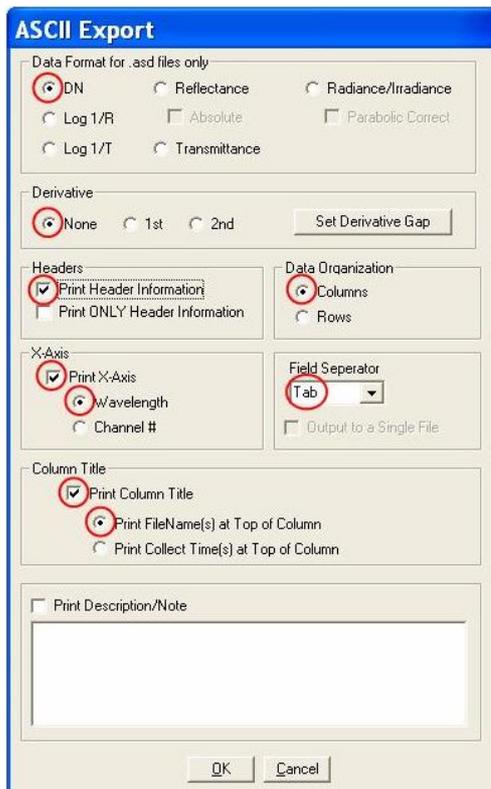
ViewSpec Pro can open and process large numbers of files although graphing is limited to 14 spectra.

- From the *File* menu select *Open* and highlight the ASD White-Ref or radiometric binary files for importation.
- Click Open to bring the files into ViewSpec Pro.

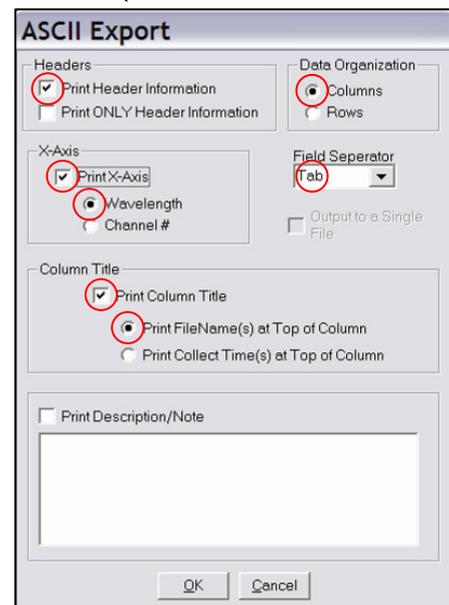
Converting ASD Binary Files to ASCII text

The file list is shown in the application window.

- Highlight each file in the list.
- From the Process menu select ASCII Export.
- Ensure the boxes/buttons circled in red are selected.
- *** NOTE** The new ASD ViewSpec Pro software allows different data formats and derivatives to be selected if required – see the dialogue box below. 'DN' and derivative - 'none' are recommended.
- Click OK to convert the files to ASCII and save them in the Output directory.
- Close the ViewSpec Pro application.



* If using the old version of ViewSpec Pro (4.05) the additional data formats are not available and the box will look like this.



2. Post Processing ASD White-Ref Reflectance Data Files

The ASD FieldSpec Pro and FS3 spectroradiometers have a feature for saving the reference measurement into the computers RAM memory (White Reference). All subsequent Target reflectance measurements are calculated with respect to the White Reference. The data file saved to the disk includes the wavelength scale and the calculated reflectance of the target.

The alternative method for taking Reflectance Measurements with the ASD FieldSpec requires two raw files to be saved to the disk, the first contains the signal intensity values for the Reference Panel, the second saved file contains the signal intensity values for the Target. Reflectance values are calculated by post processing

these two files using the second FSF template [ASD Raw Reflectance Data Template_Ver 03.XLT](#)– ref section 3.

Notes:

i) ASD binary files must be converted to ASCII text files before importing into this template.

ii) This template will not process ASD raw reflectance data files.

Excel Macro Security Level

Before the Excel templates can be opened it is necessary for the Macro Security level to be set to allow the template’s macro and Visual Basic code to be enabled.

- From the Excel *Tools* menu select *Options* and the *Security* tab.
- Click on the *Macro Security* button and change the *Security Level* to *Medium*. This will allow the macros to be manually enabled when opening the Excel template.
- If using **Excel 2007** click on the ‘office’ button in the top left corner of the screen. Excel options – Trust center. Trust center settings – macro settings – enable all macros – OK.

Opening and Saving the ASD White-Ref Reflectance Template

- Start Excel
- From the File menu Open and select the FSF Excel template:

[ASD White-Ref Reflectance Template_Ver 03.XLT](#)

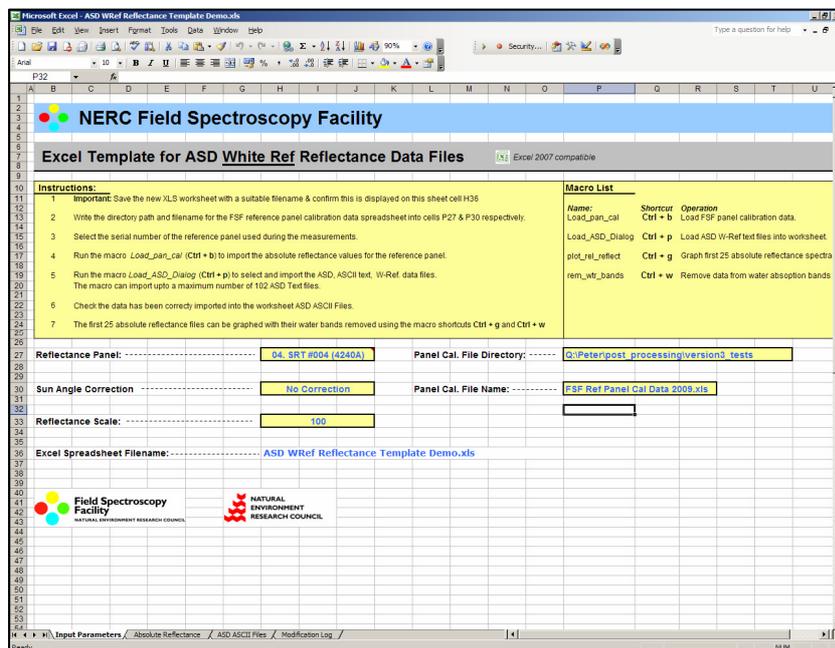
- In the Security Warning dialog click the **Enable** *Macros* button.



Note:

As the template is a read only document it needs to be opened and renamed as an Excel .XLS worksheet prior to running the macros.
In **Excel 2007**, it must be saved as a ‘macro enabled workbook’ .xlsm file.

The new spreadsheet will open on its *Input Parameters* worksheet as shown below:

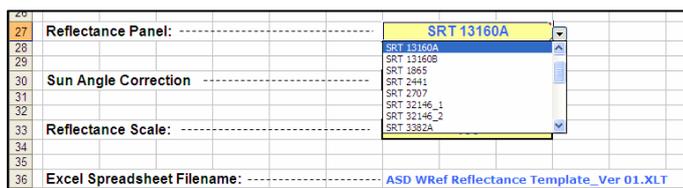


- Save the spreadsheet as an .XLS document (or .xlsm in Excel 2007) with a name and in a directory of your choice. The new name is displayed in cell H36 of the Input Parameter worksheet. Do not enter the file name into cell H36.

Setting up the Excel Template Parameters

The **Input Parameter** worksheet allows the user to select the path\directory and root filename for the reflectance panel calibration file, as well as the actual reflectance panel used for the reference measurements.

- Click on cell **H27** to bring up the pop down menu button. Click on the button to display the serial numbers of the NERC FSF calibrated reflectance panels.



Input Parameters –Cell H27
Reference Panel selection menu

- Select the serial number of the panel used during the *White Reference* measurement. *This will be used to convert the relative reflectance values into absolute spectral reflectance data. If you do not require absolute reflectance data select Panel Not Selected from the list.*
- Sun Angle Correction has not been implemented into the template at this stage.
- Set the Reflectance Scale (cell **H33**) to the desired level. Typically this is 1 or 100.
- The calibration data for the Reference panels is stored in a separate Excel spreadsheet, available from the FSF website. Carefully enter into cell **P27** the directory path where this spreadsheet is located on your computer.
- Enter into cell **P30** the name of the Reference panel calibration spreadsheet file. **NOTE:** It is important to ensure that the Reference panel calibration file corresponds to the same year that the measurements were taken. Files from previous years are archived on the FSF website, please contact FSF for further advice on this.

Macro for Importing the Selected Reference panel Calibration Data

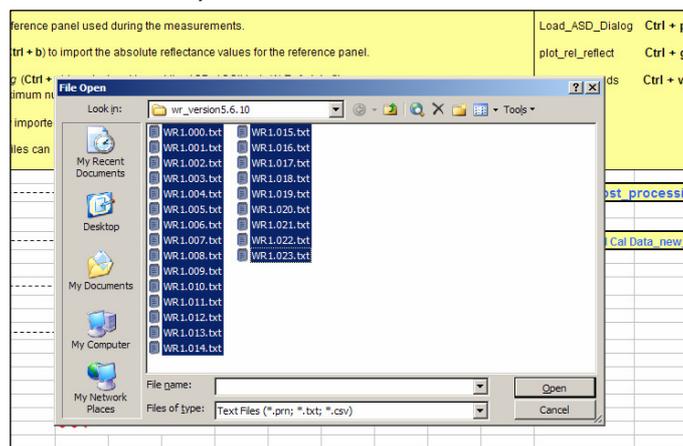
Before the data can be processed it is necessary to run the macro *load_pan_cal*. This will read the selection in cell H27 and import the calibration data from the panel calibration spreadsheet into column B of the *Absolute Reflectance* worksheet.

- Use the short-cut keys **Ctrl + b** to load the selected panel calibration data.

Importing Data with the ASD White-Ref template Macro

The Excel template can import up to a maximum of 102 ASD ASCII reflectance data files from the selected directory.

- Use the



load_ASD_Dialog macro or the short-cut keys **Ctrl + p** to bring up the dialog box and then select the text files (already converted to ASCII in section 1) you wish to process.

The output ASCII text file from ViewSpec Pro for a White Ref reflectance binary file comprises of a header with measurement parameter information, a column with the wavelength scale and a column with the relative spectral reflectance spectrum.

The template and its Macro \ Visual Basic code import all the White-Ref reflectance data files that have been selected from the 'file open' dialog box. During the importation procedure the data files names will appear and disappear from the Windows task bar. The procedure can take several minutes depending on the number of data files selected and the speed of your computer.

The ASD ASCII Files Worksheet

This worksheet shows the original data with the file header slightly reformatted. In column D in the example the file header information was deselected in ViewSpec Pro.

	A	B	C	D
1	Filename:	Lascar.000.txt	Lascar.001.txt	Lascar.002.txt
2	H_Filename:	Lascar.000	Lascar.001	Lascar.002
3	ASD Serial #	6449	6449	
4	INI Cal #	1	1	
5	Program Version:	2.03	2.03	
6	File Version:	4.03	4.03	
7	File Date:	08/03/2005	08/03/2005	
8	File Time:	16:17:39	16:33:45	
9	VNIR Int. Time:	136	136	
10	VNIR Channel #1	350	350	
11	Wavelength Int:	1	1	
12	Averaging:	500	500	
13	SWIR1 Gain	52	52	
14	SWIR1 Offset	2073	2073	
15	SWIR2 Gain:	27	27	
16	SWIR2 Offset:	2086	2086	
17	Join 1:	1000	1000	
18	Join 2:	1830	1830	
19	VNIR DC:	subtracted	subtracted	
20	DC Averaging:	500	500	
21	DC Time:	16:06:09	16:27:14	

Note:

During importation the Excel macro checks each file's header to confirm if the files are genuine White Reference measurements. Data files which do not comply are not imported.

The Absolute Reflectance Worksheet

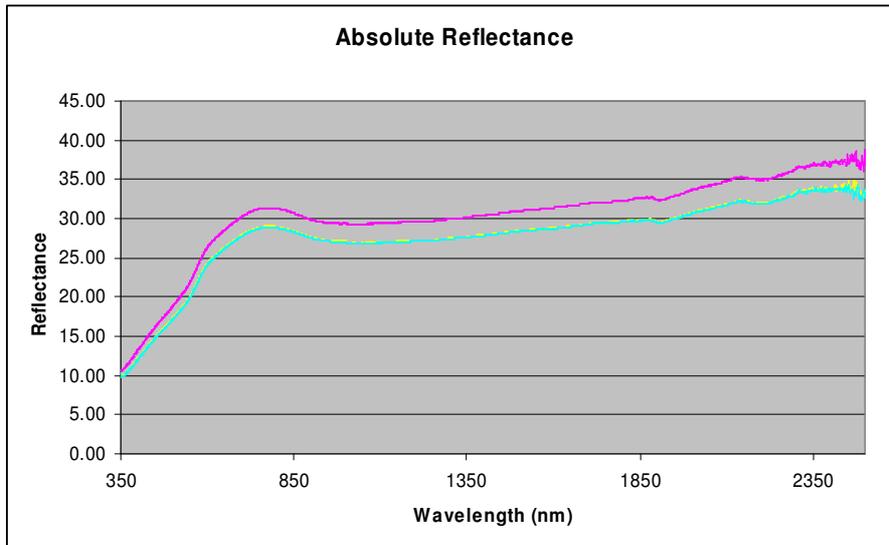
Relative spectral reflectance data from the ASD ASCII Files worksheet is multiplied with the calibration data of the selected Reflectance panel (**Reference Panels** worksheet, cell H27) to give the Absolute Spectral Reflectance values.

	A	B	C	D
1		Filename:	Lascar.000	La
2				
3				
4		Ref. Panel	Absolute	
5	Wavelength	SRT 13160A	Reflectance	
6	350	95.2%	10.54	
7	351	95.2%	10.66	
8	352	95.2%	10.68	
9	353	95.2%	10.56	
10	354	95.3%	10.72	
11	355	95.3%	10.76	
12	356	95.3%	10.75	
13	357	95.3%	10.83	

Graphing Absolute Reflectance data with the Template Macro

A simple graphing macro **plot_abs_reflect** (Ctrl + g) is available to graph the first 25 spectra in the **Absolute Reflectance** worksheet.

- Select from the Tools\Macro\Macros menu **plot_abs_reflect** or use the macro short-cut keys **Ctrl + g** to plot up to 25 spectra in the Absolute Reflectance worksheet.

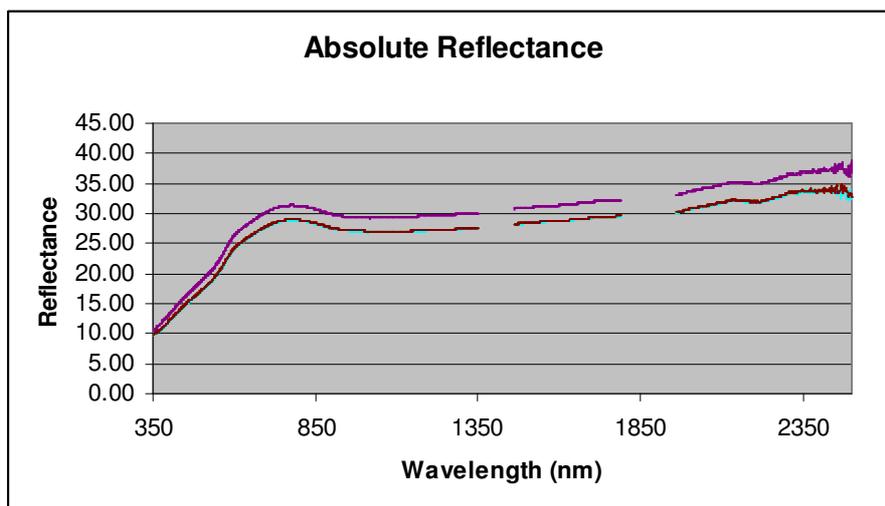


X-Y scatter plot of absolute reflectance data using the plot_abs_reflect macro (short-cut keys Ctrl + g)

Removing data from the Atmospheric Water Absorption Bands

Under certain measurement conditions the atmosphere can strongly absorb the incident downwelling radiation in two bands (1350-1460nm & 1790-1960nm) of the shortwave infrared region. As a result the reflectance data can appear very noisy in these regions. The template macro **rem_wtr_bands** deletes data across these bands in Absolute Reflectance worksheets. Note the ASD ASCII data remains untouched by this macro.

- Start the **rem_wtr_bands** Macro from the Tools \ Macro\ Macros menu or use the short cut keys **Ctrl + w**



X-Y scatter plot of absolute reflectance after the data in the water bands has been removed using the macro rem_wtr_bands (short-cut keys Ctrl + w)

Note:
The spreadsheet can now be saved for further processing.

3. Post Processing ASD Raw (DN) Reflectance Data Files

In section 2 above the ASD White Reference reflectance files are processed using the Excel template [ASD White-Ref Reflectance Template_Ver 03.XLT](#). This section uses the Excel template [ASD Raw Reflectance Data Template_Ver 03.XLT](#) to process pairs of raw digital number data files into relative and absolute reflectance spectra.

- All the ASD raw binary data files must be **first converted into ASCII** format using ASD ViewSpec Pro – ref to Section 1 in this guide.

Excel Macro Security Level

Before the Excel templates can be opened it is necessary for the Macro Security level to be set to allow the template's macro and Visual Basic code to be enabled.

- From the Excel *Tools* menu select *Options* and the *Security* tab.
- Click on the *Macro Security* button and change the *Security Level* to *Medium*. This will allow the macros to be manually enabled when opening the Excel template.
- If using **Excel 2007** click on the 'office' button in the top left corner of the screen. Excel options – Trust center. Trust center settings – macro settings – enable all macros – OK.

Opening and Saving the ASD Raw Reflectance Data Template

- Start Excel
- From the File menu Open and select the FSF Excel template:

ASD Raw Reflectance Data Template_Ver 03.XLT

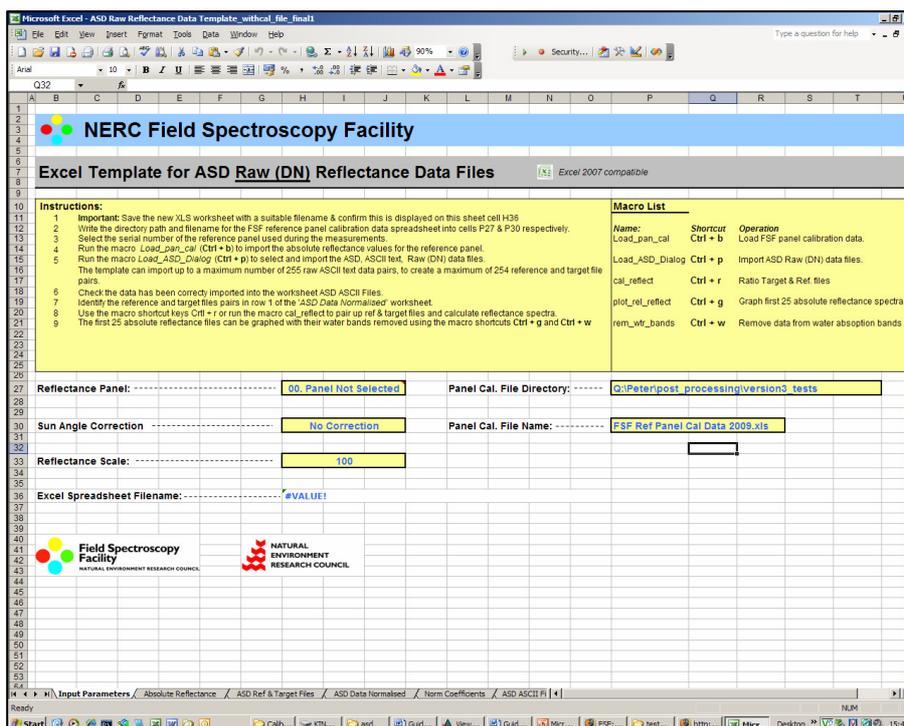
- In the Security Warning dialog click the **Enable Macro** button.



Note:

As the template is a read only document it needs to be opened and renamed as an Excel XLS worksheet prior to running the macros.
In **Excel 2007**, it must be saved as a 'macro enabled workbook' .xlsm file.

The new spreadsheet will open on its *Input Parameters* worksheet as shown below:

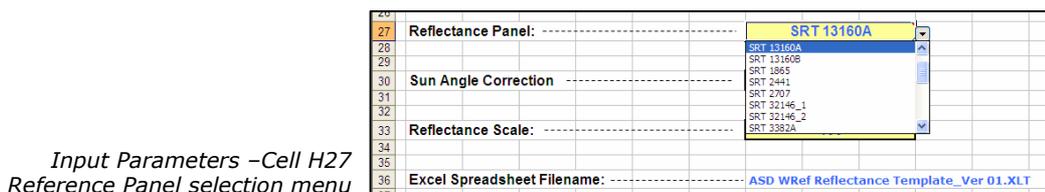


- Save the spreadsheet as an .XLS document (or .xlsm in Excel 2007) with a name and in a directory of your choice. The new name is displayed in cell H36 of the Input Parameter worksheet. Do not enter the filename directly into cell H36.

Setting up the Excel Template Parameters

The **Input Parameter** worksheet allows the user to select the path\directory and root filename for the reflectance panel calibration file, as well as the actual reflectance panel used for the reference measurements.

- Click on cell H27 to bring up the pop down menu button. Click on the button to display the serial numbers of the NERC FSF calibrated Reflectance panels.



- Select the serial number of the panel used during the *Reference* measurement. *This will be used to convert the relative reflectance values into absolute spectral reflectance data. If you do not require absolute reflectance data select 'Panel Not Selected' from the list.*
- Sun Angle Correction has not been implemented into the template at this stage.
- Set the Reflectance Scale (cell H33) to the desired level. Typically this is 1 or 100.
- The calibration data for the Reflectance panels is stored in a separate Excel spreadsheet. Enter into cell **P27** the directory path where this spreadsheet is located on your computer.
- Enter into cell **P30** the name of the Spectralon panel calibration spreadsheet file. **NOTE:** It is important to ensure that the Reflectance panel calibration file corresponds to the same year that the measurements were taken. Files from previous years are archived on the FSF website, please contact FSF for further advice on this.

Macro for Importing the Selected Spectralon Calibration Data

Before the data can be processed it is necessary to run the macro *load_pan_cal*. This will read the selection in cell H27 and import the calibration data from the panel calibration spreadsheet into column B of the *Absolute Reflectance* worksheet.

- Use the short-cut keys **Ctrl + b** to load the selected panel calibration data.

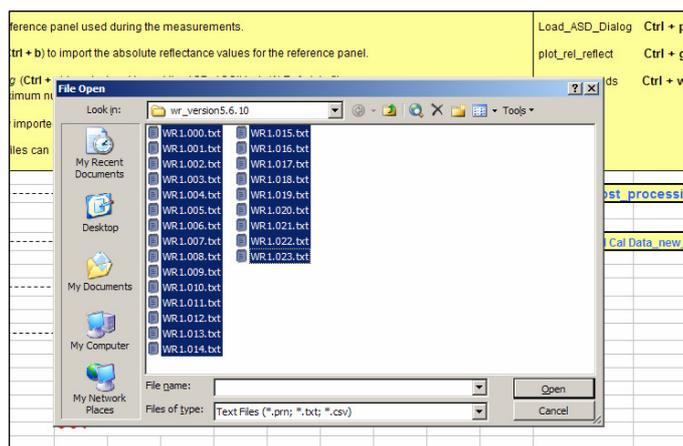
The Excel spreadsheet is now ready to import the ASCII converted raw data files.

Importing Data with the ASD Raw Reflectance Data template Macro ²

The Excel template can import up to a maximum of 255 ASD ASCII raw data files from the selected directory.

The ASCII text file created by ViewSpec Pro for a raw file comprises of a header with measurement parameter information, a column with the wavelength scale and a column with the raw spectral data.

- To import the ASCII text files run the **Load_ASD_Dialog** Macro from the Tools \ Macro\ Macros menu or use the short cut keys **Ctrl + p** to bring up the dialog box and then select the text files (already converted to ASCII in section 1) you wish to process.



The template and its Macro \ Visual Basic code import all the ASCII converted data files that have been selected from the 'file open' dialog box.

During the import procedure the data file names will appear and disappear from the Windows task bar. The procedure can take several minutes depending on the number of data files selected and the speed of your computer. Additional delay may be added as normalisation factors are calculated for each file depending on the integration times and amplifier gain settings.

The ASD Data Normalised Worksheet

This worksheet shows the original data with the file header slightly reformatted.

Note:

During importation the Excel macro checks each file's header to confirm if the files are Raw data (DN) measurements. Data files which do not comply are not imported.

Row 1 (highlighted in red) is used to manually identify the Reference files or in the case of Target files row 1 contains the column letter for this Target's Reference file. In the example shown, the Target files in columns C & D both use the reference file in column B.

	A	B	C	D
1	Reference Column:	Ref	B	B
2	Filename:	QA.020.txt	QA.021.txt	QA.022.txt
3	H_FileName:	QA.020	QA.021	QA.022
4	ASD Serial #	6449	6449	6449
5	INI Cal #	1	1	1
6	Program Version:	2.03	2.03	2.03
7	File Version:	4.03	4.03	4.03
8	File Date:	24/05/2006	24/05/2006	24/05/2006
9	File Time:	12:00:51	12:01:24	12:01:27
10	VNIR Int. Time:	136	136	136
11	VNIR Channel #1	350	350	350
12	Wavelength Int:	1	1	1
13	Averaging:	25	25	25
14	SWIR1 Gain	48	48	48
15	SWIR1 Offset	2073	2073	2073
16	SWIR2 Gain:	24	24	24
17	SWIR2 Offset:	2086	2086	2086
18	Join 1:	1000	1000	1000
19	Join 2:	1830	1830	1830
20	VNIR DC:	subtracted	subtracted	subtracted
21	DC Averaging:	25	25	25
22	DC Time:	11:59:15	11:59:15	11:59:15
23	DCC:	0	0	0
24	White reference:	Not Used	Not Used	Not Used
25	WRef Averaging:			
26	Fore Optic	5-degree	5-degree	5-degree
27	Data:	raw	raw	raw
28	Wavelength	QA.020	QA.021	QA.022
29	350	302.7957764	10.48591518	11.39436626
30	351	328.7482605	12.39860153	12
31	352	354.5244751	13.0979023	12.0979023

² Running this macro will disable the Auto Complete Cell option. To re-enable this, select Options from the Tools menu and check the Enable AutoComplete...box in the Edit tab.

- Use your log sheets to carefully identify the reference files as "Ref" or "ref" in row 1 of the 'ASD Data Normalised' worksheet.
- Each Target file now needs to be linked to its reference file, in row 1 of each Target file enter the column letter for the corresponding reference file.

When a rigid sampling scheme has been maintained the strings stored in the Example RT Strings worksheet can be copied and pasted into row 1 of ASD ASCII Data worksheet.

	A	B	C	D	E	F	G	H	I	J	K	L
1	Reference Column:	Ref	B	Ref	D	Ref	F	Ref	H	Ref	J	Ref
2												
3	Reference Column:	C	Ref	E	Ref	G	Ref	I	Ref	K	Ref	M
4												

Reference and Target strings from the Example RT Strings worksheet

Running the Reflectance Ratio Macro

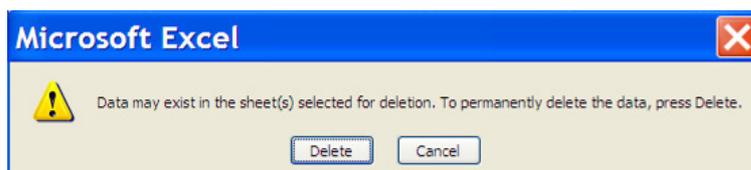
The raw spectral data files are now ready to be paired together and have their relative reflectance values calculated. The Excel macro **cal_reflect** (short-cut key **Ctrl + r**) will search through the *ASD Data Normalised* worksheet matching the Target files with their nominated reference files. These two files are copied into the *ASD Ref & Target Files* worksheet where the relative reflectance values are calculated.

- Use the macro short-cut key Ctrl + r start pairing of Target and Reference data files.

Note:

The cal_reflect macro will not run if the ASD Ref & Target worksheets have old data in them. A warning dialog will appear if the macro detects old data. Old data must be first cleared (except column A) before running the macro.

This macro may take several minutes to copy the paired files into the *ASD Ref & Target Files* worksheet and calculate the reflectance values. At the end of the macro sequence a warning dialog will appear three times seeking confirmation for the deletion of the *ASD ASCII files*, Norm Coefficients, and ASD Data Normalised worksheets. In normal operation all these files have been paired and copied into *ASD Ref & Target Files* worksheet.



- Select **Cancel** if you wish to keep the extra worksheets.
- Select **Delete** if you wish to reduce the Excel spreadsheet file size.

	A	B	C	D
1	Reference Column:	B	Ref	
2	Filename:	QA.021.txt	QA.020.txt	
3	H Filename:	QA.021	QA.020	
4	ASD Serial #	6449	6449	
5	INI Cal #	1	1	
6	Program Version:	2.03	2.03	
7	File Version:	4.03	4.03	
8	File Date:	24/05/2006	24/05/2006	
9	File Time:	12:01:24	12:00:51	
10	VNIR Int. Time:	136	136	
11	VNIR Channel #1	350	350	
12	Wavelength Int:	1	1	
13	Averaging:	25	25	
14	SWIR1 Gain	48	48	
15	SWIR1 Offset	2073	2073	
16	SWIR2 Gain:	24	24	
17	SWIR2 Offset:	2086	2086	
18	Join 1:	1000	1000	
19	Join 2:	1830	1830	
20	VNIR DC:	subtracted	subtracted	
21	DC Averaging:	25	25	
22	DC Time:	11:59:15	11:59:15	
23	DCC:	0	0	
24	White reference:	Not Used	Not Used	
25	WRef Averaging:			
26	Fore Optic	5-degree	5-degree	
27	Data:	raw	raw	
28	Wavelength	QA.021	QA.020	Reflectance
29	350	10.48591518	302.7957764	0.034630322
30	351	12.39860153	328.7482605	0.037714577

The ASD Ref & Target Worksheets

In this worksheet column A shows the wavelength scales and the file header titles. Subsequent columns (B,C and D in the example shown) display the raw target data, raw reflectance data and the Excel calculated relative reflectance values.

On this worksheet it is possible to compare the pairing up of the target and reference data files by viewing the file names, scan times and reflectance values.

Up to 85 Target/Reference/Reflectance data files sets can be viewed on this worksheet. ASD Ref & Target Worksheets II and III are used to store additional files.

The Absolute Reflectance Worksheet

Relative spectral reflectance data from the ASD Ref & Target worksheet is multiplied with the calibration data of the selected Reflectance panel (**Input parameters** worksheet, cell H27) to give the Absolute Spectral Reflectance values.

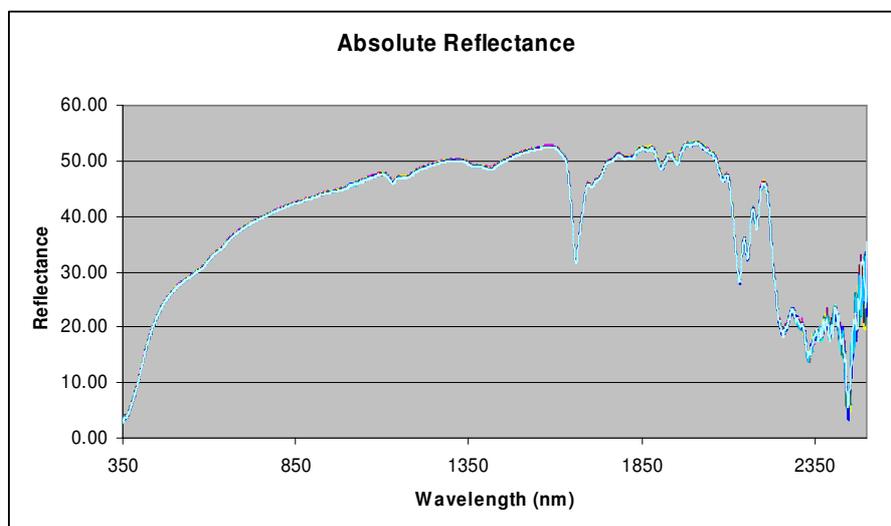
	A	B	C
1		Target Filename: QA.021.txt	
2		Reference Filename: QA.020.txt	
3			
4		Ref. Panel	Absolute
5	Wavelength	SRT 13160A	Reflectance
6	350	95.2%	3.30
7	351	95.2%	3.59
8	352	95.2%	3.52
9	353	95.2%	3.46
10	354	95.3%	3.26
11	355	95.3%	3.17
12	356	95.3%	3.40

Up to 254 absolute reflectance spectra are saved into this worksheet.

Graphing Absolute Reflectance data with the Template Macro

A simple graphing macro **plot_abs_reflect** is available to graph the first 25 spectra in the **Absolute Reflectance** worksheet.

- Select from the Tools\Macro\Macros menu **plot_abs_reflect** or use the macro short-cut keys **Ctrl + g** to plot up to 25 spectra in the Absolute Reflectance worksheet.

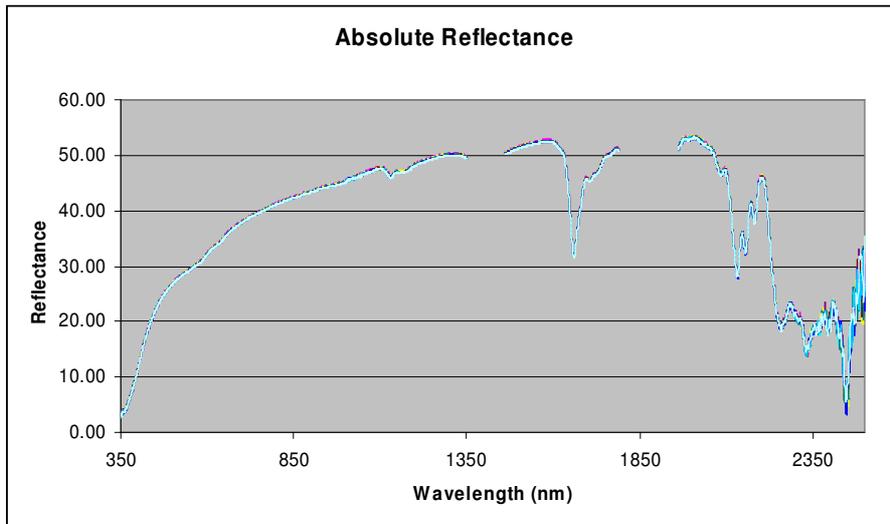


X-Y scatter plot of absolute reflectance data using the plot_abs_reflect macro (short-cut keys Ctrl + g)

Removing data from the Atmospheric Water Absorption Bands

Under certain measurement conditions the atmosphere can strongly absorb the incident downwelling radiation in two bands (1350-1460nm & 1790-1960nm) of the shortwave infrared region. As a result the reflectance data can appear very noisy in these regions. The template macro **rem_wtr_bands** deletes data across these bands in Absolute Reflectance worksheets. Note the ASD ASCII data remains untouched by this macro.

- Start the **rem_wtr_bands** Macro from the Tools \ Macro\ Macros menu or use the short cut keys **Ctrl + w**



Note:
The spreadsheet can now be saved for further processing.

X-Y scatter plot of absolute reflectance after the data in the water bands has been removed using the macro rem_wtr_bands (short-cut keys Ctrl + w)

4. Post Processing ASD Radiometric Data Files

Each of the Field Spectroscopy Facility's ASD FieldSpec Pro spectroradiometers has a number of optional fore optic accessories, which can be configured for spectral radiance or spectral irradiance measurements. However each configuration will have its own unique calibration file³ and it is essential that this file be used when converting raw spectroradiometric data into absolute radiance or irradiance values. The Excel template, which performs the necessary calculations on the ASD FieldSpec raw data, is described below. The template includes the calibration files for a variety of optical configurations.

Excel Macro Security Level

Before the Excel templates can be opened it is necessary for the Macro Security level be set to allow the template's macro and Visual Basic code to be enabled.

- From the Excel *Tools* menu select *Options* and the *Security* tab.
- Click on the *Macro Security* button and change the *Security Level* to *Medium*.
- If using **Excel 2007** click on the 'office' button in the top left corner of the screen. Excel options – Trust center. Trust center settings – macro settings – enable all macros – OK.

This will allow the macros to be manually enabled when opening the Excel template.

Opening and Saving the ASD FieldSpec Radiometric Calculator Template

- Start Excel and from the File menu Open and select the FSF Excel template for calculating absolute spectral radiometric values from raw ASD (ASCII) data files:



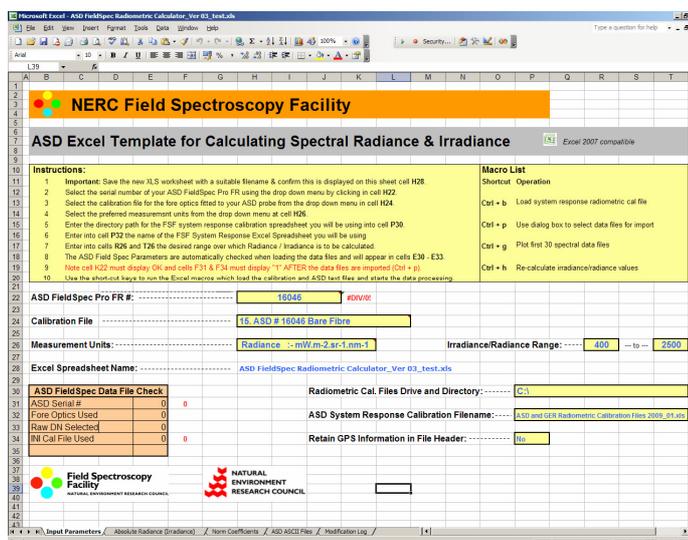
ASD FieldSpec Radiometric Calculator_Ver 03.XLT

- In the Security Warning dialog click the **Enable Macro** button.

The new spreadsheet will open on its *Input Parameters* worksheet as shown below:

- Save the spreadsheet as an .XLS document with a name and directory of your choice. The new name is displayed in cell H28 of the Input Parameter worksheet.

Note:
As the template is a read only document it needs to be opened and renamed as an Excel .XLS worksheet, prior to running the macros.
If using **Excel 2007**, it will need to be saved as a .xlsm (macro enabled excel worksheet).



The 'Input Parameters' worksheet from the ASD Spectral radiance & Irradiance Calculator spreadsheet.

³ Unlike the more commonly measured spectral reflectance.

Setting up the Excel Template Parameters

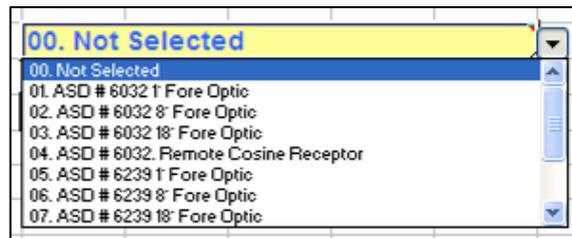
The **Input Parameter** worksheet allows the user to select the instrument serial number, the calibration file that corresponds to the optical configuration used with the instrument, the measurement units and Radiance / Irradiance range. The user also needs to specify the path/directory and root filename for the system response calibration file here.

- The serial number of the spectroradiometer must be recorded into cell **H22**. This is used to all ensure the data files match and to assist in the generation of the normalising coefficients.

Note:

It is critical that the correct system response calibration file is selected. Please ensure the instrument serial number and fore optic exactly matches your measurement setup. A warning label is shown in cell N24 to indicate the mismatch of the ASD serial number and the selected calibration file. This will clear when the setup process is correctly completed. It is also important to ensure that the system response calibration file corresponds to the same year that the measurements were taken. Files from previous years are archived on the FSF website, please contact FSF for further advice on this.

- Click on cell **H24** to bring up the pop down menu button. Click on the button to display the 18 calibration files available for the ASD field spectroradiometers and their various **Fore Optic** accessories.



- From the drop down list select the system response calibration file, which matches the serial number of the ASD spectrometer used, and its fore optic. *This will be used to convert the raw data values into absolute spectral radiance or irradiance.*
- Confirm the warning label in cell **N24** is now cleared.
- Click on cell **H26** and select from the drop down menu your measurement type and preferred units.
 - Radiance $\text{mW m}^{-2} \text{sr}^{-1} \text{nm}^{-1}$
 - Radiance $\mu\text{W cm}^{-2} \text{sr}^{-1} \text{nm}^{-1}$
 - Irradiance $\text{mW.m}^{-2} \text{sr}^{-1} \text{nm}^{-1}$
 - Irradiance $\mu\text{W.cm}^{-2} \text{sr}^{-1} \text{nm}^{-1}$
- The system response calibration data for the ASD with its foreoptic is stored in a separate Excel spreadsheet. Enter into cell **P30** the directory path where this spreadsheet is located on your computer.
- Enter into cell **P32** the name of the Spectralon panel calibration spreadsheet file.

- Enter into cells **R26** and **T26** the desired range over which the radiance / irradiance value is calculated. The maximum range from 350 to 2500nm. Note R26 must be less than T26. The radiance/irradiance values are shown in the *Absolute Radiance (Irradiance)* worksheet.
- Change cell **P34** to 'yes' if GPS information has been used as an additional data input during data collection, and you wish to retain it in the file header. The default for this is 'no'.

Running the template Macros

The Excel template includes four macros

- To load the ASD's system response calibration file
- To import, format, normalise to unity gain / integration time and calculate the radiometric values from the ASD ASCII text data files
- To graph the first 30 calculated radiometric data files
- To recalculate the irradiance/radiance values

Each of these Excel macros can be run from the Tools / Macro menu or by using the short-cut keys listed on the Input Parameters worksheet.

Macro for Importing the System Response Calibration Data

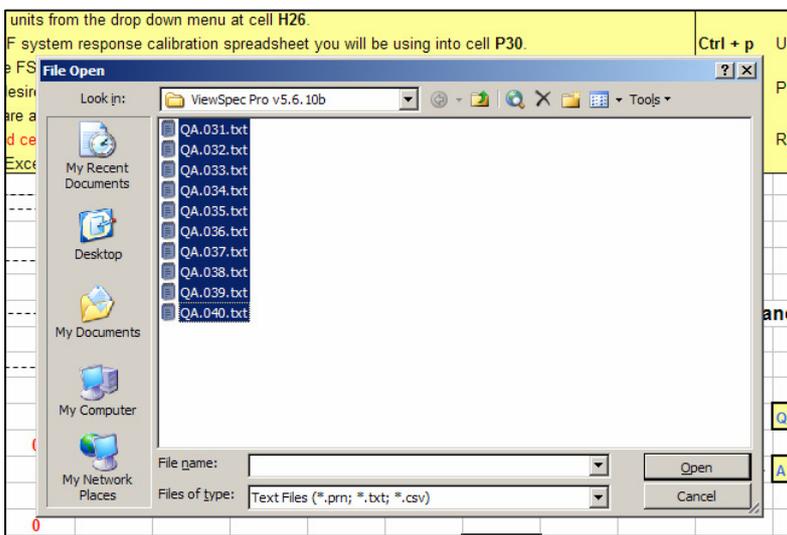
Before the data can be processed it is necessary to run the macro *load_sys_res_cal*. This will read the selection in cell H24 and import the calibration data from the radiometric calibration spreadsheet (detailed in cells P30 and P32) into column B of the *Absolute Radiance (Irradiance)* worksheet.

- Use the short-cut keys **Ctrl + b** to load the selected system response cal. data.

Importing Data with the Load_ASD_ASCII_data_file_dialog Macro

The excel template can import up to a maximum of 102 data files for processing. The ASCII text data files (which should already have been converted in ViewSpec Pro – see section 1) comprise of a file header with measurement parameters, a column with the wavelength scale (350 – 2500nm, 1nm interval) and a column with the raw spectral data.

- Start the **Load_ASD_ASCII_data_file_dialog** Macro from the Tools \ Macro\ Macros menu or use the short cut keys **Ctrl + p**
- A 'File open' dialogue box will prompt you to navigate to the relevant directory and select all the .txt files that you wish to import into the template. Highlight these and then click 'open'.



The template and its Macro \ Visual Basic code import all the data files selected in the dialogue box, up to 102 files.

During the importation procedure the data file names will appear and disappear from the Windows task bar. The procedure can take several minutes depending on the number of data files selected and the speed of your computer. A further delay is to be expected as Excel calculates the normalising coefficients for each point in each spectral file over the range 350 – 2500nm.

The ASD ASCII Files worksheet

This shows up to 102 raw data files with the file header formatted into one column. Data stored in the files header includes:-

- ASD serial number & settings
- Measurement dates & times
- Dark signal averaging
- Measurement averaging
- Fore optic selection
- Measurement type

	A	B	C	D
1	Filename:	100_8.000.txt	100_8.001.txt	100_8.002.txt
2	H_Filename:	100_8.000	100_8.001	100_8.002
3	ASD Serial #	6032	6032	6032
4	INI Cal #	3	3	3
5	Program Version:	9	9	9
6	File Version:	4.03	4.03	4.03
7	File Date:	22/02/2006	22/02/2006	22/02/2006
8	File Time:	17:33:45	17:33:50	17:33:53
9	VNIR Int. Time:	136	136	136
10	VNIR Channel #1	350	350	350
11	Wavelength Int:	1	1	1
12	Averaging:	25	25	25
13	SWIR1 Gain	16	16	16
14	SWIR1 Offset	2050	2050	2050
15	SWIR2 Gain:	16	16	16
16	SWIR2 Offset:	2078	2078	2078
17	Join 1:	987	987	987
18	Join 2:	1795	1795	1795
19	VNIR DC:	subtracted	subtracted	subtracted
20	DC Averaging:	25	25	25
21	DC Time:	22:33:23	22:33:23	22:33:23
22	DCC:	0	0	0
23	White reference:	not	not	not
24	Fore Optic	8-degree	8-degree	8-degree
25	Data:	raw	raw	raw
26	Wavelength	100_8.000	100_8.001	100_8.002
27		350	22.36859131	23.21239471
28		351	23.50943756	24.59971809
29		352	24.70884098	25.40820894

The Norm Coefficients Worksheet

Each spectral data files has a column of coefficients generated to normalise the data for changes in InGaAs detector amplifier gains or integration times for the VisNIR silicon array detector

Data extracted from the file headers includes the VISNIR integration time, SWIR1 & 2 gains and Join 1 & 2, the wavelength at which the spectral data switches from the channels 1 to 2 and channel 2 to 3.

	A	B	C	D
1		100_8.000	100_8.001	100_8.002
2	VNIR Int. Time	136	136	136
3	SWIR1 Gain	16	16	16
4	SWIR2 Gain	16	16	16
5	Join 1	987	987	987
6	Join 2	1795	1795	1795
7	350	136	136	136
8	351	136	136	136
9	352	136	136	136
10	353	136	136	136
11	354	136	136	136
12	355	136	136	136
13	356	136	136	136
14	357	136	136	136
15	358	136	136	136
16	359	136	136	136
17	360	136	136	136
18	361	136	136	136

Norm Coefficients Worksheet

The Absolute Radiance (Irradiance) Worksheet

Spectral data from the ASD ASCII worksheet is normalised using the coefficients above and scaled to absolute radiometric values by multiplying each spectral value with its unique cal. factor from the chosen system response calibration file.

	A	B	C	D	E	F	G
1		Filename:	RAD_8DEG.000.txt	RAD_8DEG.001.txt	RAD_8DEG.002.txt	RAD_8DEG.003.txt	RAD_8DEG.004.txt
2							
3		Radiance: W/m ² /sr	110.3	110.3	110.3	110.3	110.3
4		PAR (μmol/m ² /s):	65.3	65.3	65.3	65.3	65.3
5		Luminance: cd/m ²	3326.3	3326.3	3326.3	3326.5	3326.3
6							
7		Spectral Units:	mW.m-2.sr-1.nm-1	mW.m-2.sr-1.nm-1	mW.m-2.sr-1.nm-1	mW.m-2.sr-1.nm-1	mW.m-2.sr-1.nm-1
8	Cal File Date:	29 March 2007	Spectral	Spectral	Spectral	Spectral	Spectral
9	Wavelength (nm)	Selected Cal File	Radiance	Radiance	Radiance	Radiance	Radiance
10	350	2.076	1.672	1.661	1.658	1.650	1.650
11	351	2.010	1.719	1.712	1.700	1.704	1.697
12	352	1.960	1.751	1.767	1.750	1.780	1.744
13	353	1.882	1.816	1.818	1.803	1.826	1.803
14	354	1.822	1.876	1.867	1.862	1.878	1.862
15	355	1.774	1.932	1.916	1.924	1.934	1.921
16	356	1.726	1.995	1.983	1.980	1.996	1.965
17	357	1.685	2.051	2.044	2.037	2.047	2.031
18	358	1.647	2.103	2.102	2.096	2.099	2.098
19	359	1.610	2.150	2.156	2.159	2.166	2.148
20	360	1.574	2.214	2.207	2.214	2.230	2.217
21	361	1.542	2.280	2.269	2.272	2.289	2.281
22	362	1.514	2.346	2.349	2.339	2.344	2.333
23	363	1.492	2.413	2.410	2.411	2.413	2.397

Absolute Radiance (Irradiance) Worksheet

The data is further scaled to match the selected measurement units for radiance or irradiance measurements, depending on the units selected in cell H26 of the 'input parameters' worksheet:

- Radiance mW m⁻² sr⁻¹ nm⁻¹
- Radiance μW cm⁻² sr⁻¹ nm⁻¹
- Irradiance mW.m⁻² sr⁻¹ nm⁻¹
- Irradiance μW.cm⁻² sr⁻¹ nm⁻¹

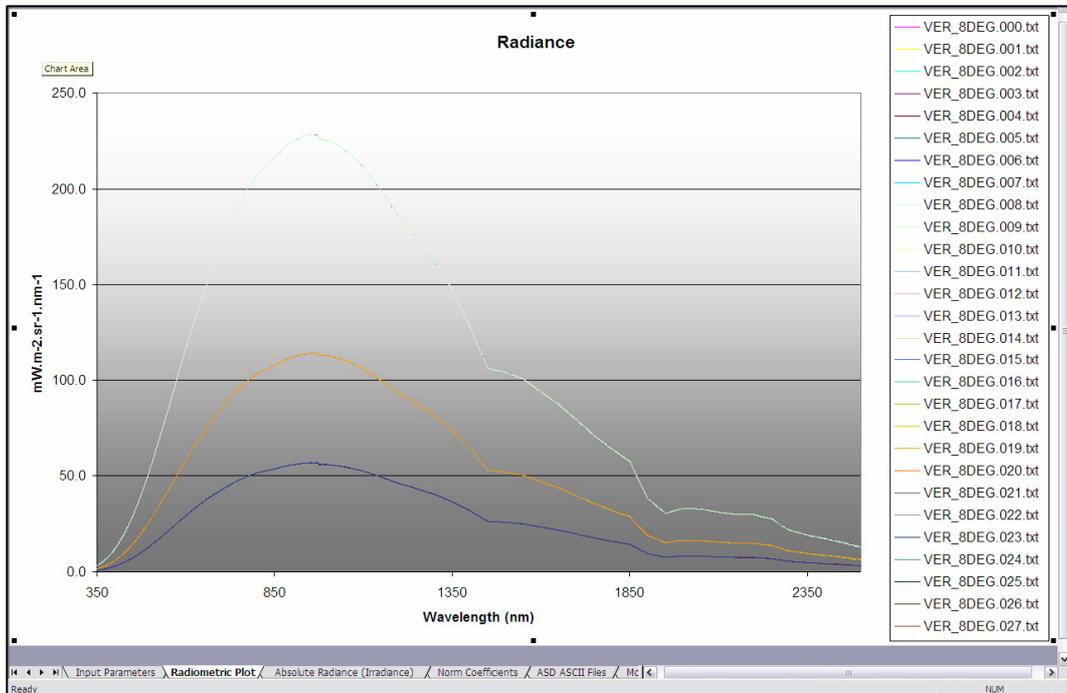
Rows 3, 4 and 5 of the Absolute Radiance (Irradiance) worksheet display the radiance (irradiance), PAR and luminance (illuminance) for each of the spectral data files. The radiometric data is calculated over the spectral region selected in cells R26 and T26 of the *Input Parameters* worksheet.

- Use the short-cut keys **Ctrl + h** to run the template macro *recal_rad_values* which recalculates the radiometric values after making changes to the irradiance/radiance range cells (R26 & T26).

Graphing Radiometric Data with the Excel Macro `plot_rad_irrad`

The graphing macro `plot_rad_irrad` automatically plots the first 30 available spectra in the **Absolute Radiance (Irradiance)** worksheet.

- From the Tools\ Macros menu select and run the macro `plot_rad_irrad` or use the macro short-cut keys **Ctrl + g**



X-Y scatter plot of absolute spectral radiance in $\text{mW m}^{-2} \text{sr}^{-1} \text{nm}^{-1}$ using the macro `plot_rad_irrad`

Note:
The spreadsheet can now be saved for further processing.