SpecCal v.1.2 – User's Guide

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Introduction and note for the users

This user's guide provide information for the use of the SpeCal v.1.2 software.

SpecCal is a stand-alone IDL application for the in-field spectral calibration of high-resolution spectrometers, based on the spectral matching algorithm proposed by Meroni et al. (2010)[1].

SpecCal was developed by **Lorenzo Busetto** (GUI development, Software optimization, Debugging) and **Michele Meroni** (Algorithm development and testing, Software optimization) of the Environmental Dynamics Remote Sensing Laboratory of the University of Milano-Bicocca, Italy. Information for contacting the authors is reported at the end of this document.

SpecCal is distributed as a Microsoft Windows executable file exploiting the IDL Virtual Machine©. This allows the execution of the software without the need of a working IDL license. Distributions for other operating systems may be available in the future. The source code of the different routines is distributed along with the executable file to allow the users to modify the software to better suite their needs.

SpecCal is distributed as free software. Redistribution and use in source and binary forms **for non-commercial purposes**, with or without modification, are permitted by the authors subject to the following restrictions:

- The origin of the software must not be misrepresented: you must not claim you wrote the original software.
- If you use the software in a product or application, an acknowledgment in the product documentation would be greatly appreciated by the authors.
- Altered source versions should be plainly marked as such, and must not be misrepresented as being the original software.

SpecCal is distributed in the hope that it will be useful, but WITHOUT ANY WARRANTY; without even the implied warranty of MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE.

The user's of SpecCal are encouraged to report to the authors eventual bugs and malfunctioning of the software. Reports regarding good or bad performances of SpecCal on specific input data are also encouraged.

The following public-domain IDL routines of other authors are used by SpecCal, and their source code is distributed with the software:

- *ERROR_MESSAGE, FSC_COLOR, GREEK, PICKCOLORNAME, PROGRAMROOTTODIR, PROGRESSBAR__DEFINE, WRITE_CSV_DATA*: Written by **David Fanning** (FANNING SOFTWARE CONSULTING) Available online at http://www.dfanning.com/documents/programs.html

- *LOWESS, ROB_CHECKFIT, ROBUST_LINEFIT, ROBUST_POLY_FIR, ROBUST_SIGMA*: Written by **H.T. Freudenreich.** Available on line at the IDL Astronomy User's Library - http://idlastro.gsfc.nasa.gov/

[1] Meroni, M., Busetto, L., Guanter, L. *et al.*, 2010. Characterization of fine resolution field spectrometers using solar Fraunhofer lines and atmospheric absorption features. Applied Optics, ID 124696 (posted 04/05/2010, in press).

- *LEGEND*: Written by **F.K. Knight**. Available on line at the IDL Astronomy User's Library - http://idlastro.gsfc.nasa.gov/
- *SAVEIMAGE*: Written by **Liam E. Gumley** – Available online at www.gumley.com/PIP/Programs/saveimage.pro
- *TNMIN*: Written by **Craig B. Markwardt** – Available online at http://www.physics.wisc.edu/~craigm/idl/down/tnmin.pro
- *DIALOG_CHOICE*: by **Ben Tupper**

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Installation Instructions

SpecCal is entirely written in IDL© v.7.1 (Interactive Data Language, ITTVIS 2010 – www.ittvis.com). The present distribution includes both the source code, and a Microsoft Windows executable file exploiting the IDL Virtual Machine©, to allow its execution also without a working IDL license. Executable files for other Operating Systems may be available in the future, or can be requested directly to the authors.

SpecCal can be installed by following the following simple steps:

1) Decompress the archive

All the files necessary to run SpecCal are distributed in the compressed archive "SpecCal_v12.zip". The users should first of all **decompress the archive** in an empty installation folder of their choice. When decompressing the archive, the users should check that the option specifying to **extract the full paths of the files** is selected within the decompressing software of choice (e.g., WINZIP, WINRAR, etc.)

2) Check the installation folder

After the decompression, the following sub-folders should have been created in the selected installation folder:

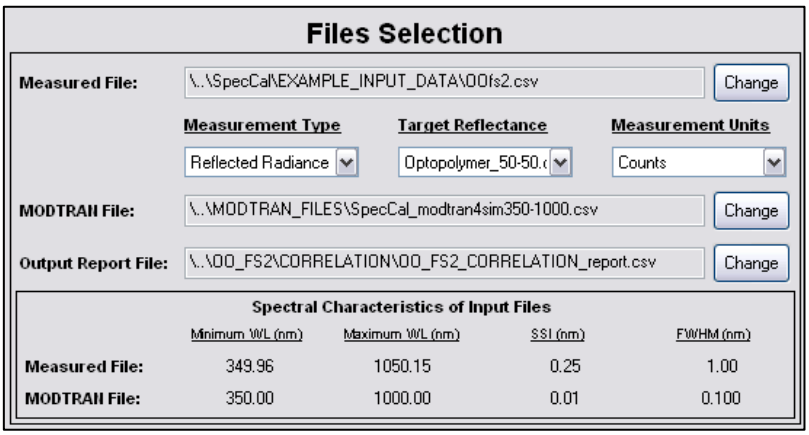
- **EXAMPLE_INPUT_DATA**: Contains the example input data provided with the distribution in order to allow the users to test the software (See the *"Example Data"* section of this guide for further details)
- **EXAMPLE_OUTPUT_DATA** : Contains the example output data provided with the distribution in order to allow the users to test the software (See the *"Example Data"* section of this guide for further details)
- **HELP**: Contains a copy of this User's Guide.
- **LOG_FILES**: Initially empty. Log files of SpecCal executions are saved in this folder.
- **MODTRAN_FILES**: Contains two example MODTRAN irradiance files (See the *"Files Selection – MODTRAN File"* section of this guide for further details).
- **OUTPUTS**: Initially empty. By default, SpecCal prompts the user to save the output files in this folder
- **PREVIOUS**: Initially empty. After the first successful execution, it will contain the file *"previous_SpecCal.sav"*, which stores the input files and computation parameters used in the last successful execution.
- **SOURCE**: Contains the source IDL code of the different SpecCal routines. It is organized as follows:
    - *FUNC_PRO*: Contains different IDL procedures and functions exploited by SpecCal. Routines in the "EXTERNAL" subfolder were not written by SpecCal authors.
    - *GUI*: Contains the SpecCal routines governing the functioning of the GUI.
    - *MAIN*: Contains the two main SpecCal routines (SpecCal_Main.pro and SpecCal_core.pro).

- **TARGET_REFLECTANCES**: Contains two example Target Reflectance Files: Standard_White_Reference.csv and Optopolymer_50-50.csv (See the "*Files Selection – Measured File Characteristics*" section of this guide for further details)

3) Run the software

To run the software, open the "*SpecCal_12.exe*" file within the main installation folder. When the IDL Virtual Machine splash screen appears, click on "*Continue*", and the SpecCal GUI should appear.

File Selection



File Selection Area of the SpecCal GUI

This section of the GUI allows the selection of the input files names and characteristics, and of the name of the output CSV report file to be produced.

Measured File

The selected file must contain the measurement data to be used as input for the calibration. The file must be saved as a three-columns semi-column delimited CSV file.

The first row must contain the columns headers. Starting from the second row, the first column of data must contain the wavelengths (WL) expressed in nm, the second the measured data and the third the nominal FWHM of the instrument (expressed in nm). Only the first row of the third column should be filled.

An example of how the Measured File should appear when opened with a text editor is given below.

	Col 1	*Col 2*	*Col 3*
Row 1	WL(nm) ;	DATA ;	FWHM
Row 2	350.0 ;	0.0242 ;	3.50
Row 3	351.0 ;	0.0244 ;	
	.... ;	.... ;	
Row N	1050.0 ;	0.0473 ;	

Required formatting for the Measured File

Measured File Characteristics

The three menus below the Measured File selection area allow to specify the characteristics of the selected file.

Measurement Type Menu

Allows to specify how the spectral data were acquired. The following options can be selected:

- ***Reflected Radiance***: Select this option if the Measured File selected as input was acquired by measuring the radiance reflected by a target of known reflectance using a down-looking optic. (N.B. If this option is selected, the user must also select the correct option in the *Target Reflectance* menu).
- ***Solar Irradiance***: Select this option if the Measured File selected as input was acquired by directly measuring the incident solar irradiance using a sky-looking cosine-response optic.

Target Reflectance Menu

Allows to specify the reflectance of the observed (Available only if the Measurement Type is set to *Reflected Radiance)*.The following options can be selected:

- ***None***: Select this option if data reported in the Measured file was already corrected for the target's reflectance.
- ***Standard White Ref.***: Select this option to use a standard white panel constant reflectance of 0.98 as target.
- ***Change File***: Select this option to be able to choose a user-defined file specifying the spectral reflectance of the target from 350 to 1050 nm. The user-defined target reflectance file should be **a semi-column delimited CSV file with 2 columns and 701 rows**. The first row contains the column headers. Starting from the second row, the first column must contain the wavelengths, and the second the target reflectance, sampled with a SSI of 1 nm. An example of how the Target Reflectance File should appear when opened with a text editor is given below.

	Col 1		Col 2
Row 1	WL(nm)	;	Reflectance
Row 2	350.0	;	0.053
Row 3	351.0	;	0.057
....	....	;	.....
Row 701	1050.0	;	0.120

Required formatting for the user-defined Target Reflectance File

Measurement Units Menu

Allows to specify if the Measured File contains data expressed in some physical units, or in raw counts. Two options are available:

- ***Physical Units***: Select this option if the Measured File was already radiometrically calibrated, so that it contains data expressed **in appropriate physical units** (e.g., W m^{-2} ste^{-1} μm^{-1}).
- **Counts**: Select this option if the Measured File was not radiometrically calibrated, so that it contains data expressed in **counts** (nb: if this option is selected, the software performs an on-the-fly radiometric calibration of the measured spectra prior to the spectral calibration).

MODTRAN File

The MODTRAN file must contain the simulated high-resolution MODTRAN4 simulated incident irradiance file to be used as reference for the spectral matching algorithm. The file must be saved as a three-columns semi-column delimited CSV file.

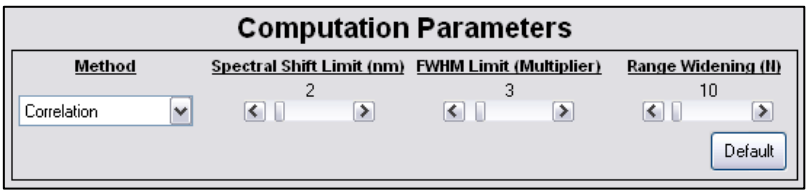
The first row must contain the columns headers. The first column of data must contain the wavelengths (WL) expressed in nm, the second the simulated irradiance data and the third the nominal FWHM of the instrument (expressed in nm). Only the first row of the third column should be filled.

An example of how the MODTRAN irradiance file should appear when opened with a text editor is given below.

	Col 1	Col 2	Col 3
Row 1	WL(nm) ;	DATA ;	FWHM (nm)
Row 2	350.0 ;	0.0220 ;	0.01
Row 3	351.0 ;	0.0214 ;	
	.... ;	.... ;	
Row N	1050.0 ;	0.0440 ;	

Required formatting for the MODTRAN File

Computation Parameters



Computation Parameters Area of the SpecCal GUI

This area of the GUI allows the selection of the computation parameters to be used in the analysis.

Method Menu

Allows to specify how the method to be used for the spectral calibration. Two options are available:

- ***Ratio***: Use the *Ratio* method (see Meroni et al., 2010 for reference)
- ***Correlation***: Use the *Correlation* method (see Meroni et al., 2010 for reference)

For a description of the theoretical backgrounds of the two methods the user can refer to:

Meroni, M., Busetto, L., Guanter, L. *et al.*, 2010. Characterization of fine resolution field spectrometers using solar Fraunhofer lines and atmospheric absorption features. Applied Optics, ID 124696 (posted 04/05/2010, in press)

Spectral Shift Limit (nm)

Allows to specify the width of the interval within which the true SS of the instrument is searched, at each absorption window. True SS is searched between plus and minus the specified limit. Default value is 1 nm.

FWHM Limit (multiplier)

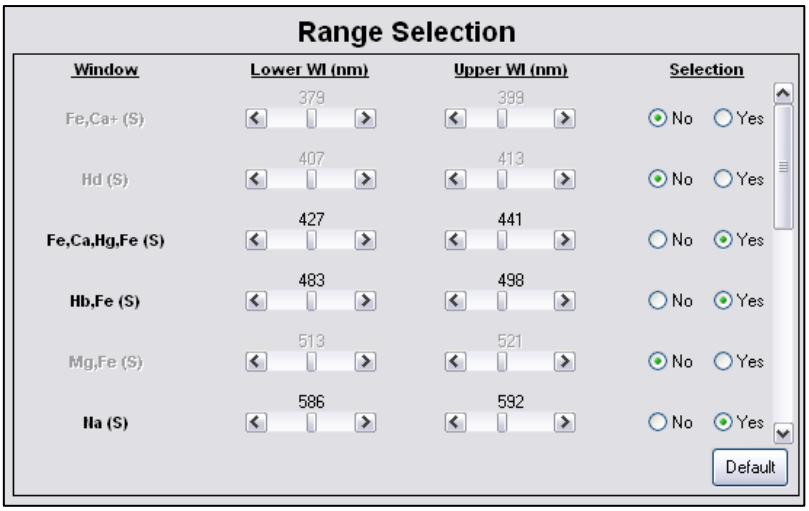
Allows to specify the width of the interval within which the true FWHM of the instrument is searched, at each absorption window. FWHM is searched between $FWHM_{nominall}/FWHM_{Limit}$ and $FWHM_{nominal} \cdot FWHM_{Limit}$ ($FWHM_{nominall}$ is the theoretical FWHM of the instrument, derived from results of the last performed calibration). Default value is 2.

Range Widening (N)

Allows to specify how many channels on the left and on the right of the absorption windows should be considered in the analysis. This influences the total width of the spectral ranges considered in the computation of the spectral parameters *(See the section Range Selection of this User's Guide for further details)*. Default value is 10. It is suggested to keep RW to its default value unless the spectrometer analyzed has a moderate resolution (e.g., > 3 nm)

The user can reset all values to default by pressing the "*Default*" on the right side of the GUI.

Range Selection



Range Selection Area of the SpecCal GUI

Allows the selection of the absorption windows to be considered in the processing, and the fine-tuning of the width of the spectral ranges used in the calibration.

Only the absorption windows comprised in the wavelength range covered by both the measured and the MODTRAN spectra are available for the processing, while the other ones are grayed out and automatically excluded. The available windows can be excluded from the processing by using the "Yes" and "No" buttons on the right side of the GUI.

The "Lower WL" and "Upper WL" sliders allow to adjust the width of the spectral ranges. Default values are computed for each window as a function of the Range Widening value and of the nominal Spectral Sampling Interval (SSI) of the instrument:

$$\begin{cases} Lower\ WL = \lambda_{min} - RW \cdot SSI \\ Upper\ WL = \lambda_{max} + RW \cdot SSI \end{cases}$$

The limits within which each slider can be adjusted are computed as:

$$Lower\ WL\ Sliders: \begin{cases} MIN = \max((\lambda_{min} - 2 \cdot RW \cdot SSI)\,; \min(wl_{meas})\,; \min(wl_{MOD})) \\ MAX = \lambda_{min} \end{cases}$$

$$Upper\ WL\ Sliders: \begin{cases} MIN = \lambda_{max} \\ MAX = \min\big((\lambda_{min} + 2 \cdot RW \cdot SSI)\big)\,; \max(wl_{meas})\,; \max(wl_{MOD})) \end{cases}$$

The user can reset all values to default by pressing the *"Default"* button on the right side of the GUI.

Minimum and maximum wavelengths used for each absorption window are shown in the following table.

WINDOW N°	ELEMENT	ORIGIN	λ_{min}	λ_{max}
		(Solar/Terrestrial)	(nm)	(nm)
1	Fe, Ca+	S	382	397
2	Hd	S	410	410.3
3	Fe and Ca, Hg, Fe	S	430	438
4	Hb, Fe	S	486	496
5	Mg, Fe	S	516	518
6	Na	S	589	590
7	Ha	S	656.1	656.5
8	O_2 (-B)	T	686	688
9	Water vapor	T	716	735
10	O_2 (-A)	T	759	770
11	O_2 (-Z), Water vapor	T	809	841
12	Ca II	S	849	866
13	Water vapor	T	925	980

Origin and minimum and maximum wavelengths of the different available absorption windows

Besides at the preselected windows, the calibration can be performed on a "Broad" spectral region. By default, this region covers the whole wavelength range encompassed by both the measured and MODTRAN spectra, but its limits can be modified as needed.

The user may also perform the analysis on a user-defined spectral region which minimum and maximum wavelengths can be manually defined in the last row of the "Range Selection" frame.

Suggestions for spectral ranges selection

- The selection of the windows to be processed should take into account the characteristics of the instrument to be calibrated. For example, using the narrow Fraunhofer lines for calibration of spectrometers with FWHM > 3 nm may yield inaccurate results, since the absorption features may not be resolved, or only poorly resolved, in the measured spectra.
- As a rule of thumb, the width of the spectral regions should be kept as narrow as possible, yet guaranteeing that a sufficient number of channels is used for the analysis. To this aim, we suggest to keep RW to its default value unless the spectrometer analyzed shows a moderate resolution (e.g., > 3 nm).

Plotting Options

Plotting Options Area of the SpecCal GUI

Allows to specify the plotting options for the outputs. Each plotting option can be checked or unchecked independently.

Plot to screen

If selected, a graph showing the results of the calibration at each of the selected absorption windows is plotted to the screen.

Save Plots as TIFF

If selected, the graphs are saved as TIFF files in the same folder of the output CSV report file. The name of the produced TIFF files is given by the name of the CSV output report file, plus a suffix which indicates to what absorption window the graph refers (e.g.: Report file = "HH_RADIANCE_report" → TIFF File = "HH_RADIANCE_report_420-448.tiff")

Save Data as CSV

If selected, the data used to create each graph are saved in a CSV file in the same folder of the output CSV report file. The name of the produced CSV files is given by the name of the CSV output report file, plus a suffix which indicates to what absorption window the graph refers (e.g.: Report file = "HH_RADIANCE_report" → TIFF File = "HH_RADIANCE_report_420-448_plt.csv").

Outputs

Output Report File

Results of the spectral calibration are saved in semi-column delimited CSV format in the output report file selected by the user. The first line of the report file contains the column headers. Each successive row contains information on the results of the spectral calibration at one of the selected absorption windows. Data reported in the different column is specified below:

	COLUMN N°	COLUMN HEADER	ASSOCIATED DATA
Range Wavelengths	1	Range_wl_min	Minimum wavelength of the spectral range considered in the cost function minimization
	2	Range_wl_max	Maximum wavelength of the spectral range considered in the cost function minimization
	3	Range_center	Central wavelength of the spectral range considered in the cost function minimization
Calibration Results	4	SS_cal	Spectral Shift estimated for the instrument at the absorption window. (The true acquisition wavelengths are equal to the nominal wavelengths + the SS)
	5	FWHM_cal	FWHM estimated for the instrument at the absorption window
	6	Cost Function (@SS_cal and FWHM_cal)	Final value of the cost function
	7	Minimization Status	Final status of the minimization
Computation Parameters	8	Method	Method used for the calibration (Ratio or Correlation)
	9	Measurement Type	Mesurement Type (Solar Irradiance or Reflected Radiance)
	10	Measurement Units	Mesurement Units (Physical units or Counts)
	11	Nominal FWHM	Nominal FWHM of the instrument (Form factory calibration)
	12	Spectral Shift Limit (+/- limit)	Parameter used to compute the search interval for SS_cal (SS_cal is searched between + and minus the SS limit)
	13	Fwhm Limit (*/ limit)	Parameter used to compute the search interval for FWHM_cal (FWHM_cal is searched between FWHM_nominal/FWHM_limit and FWHM_nominal*FWHM_limit))
	14	N° of channels	Total number of channels included in the spectral range considered in the minimization
	15	Range Widening	Range Widening Value
	16	Smoothing Filter HW	Half Width of the smoothing filter used in the Ratio method
Input Files	17	Measured file	Input Measured File
	18	MODTRAN file	Input MODTRAN Irradiance File
	19	Target reflectance file	Target Reflectance File
Messages	20	Messages	Optional debugging messages regarding the minimization process

Description of the different columns of the Output Report File

The Minimization Status column provides synthetic information about the success or failure of the optimization. The meaning of the different status values is summarized below:

MINIMIZATION STATUS VALUE	MEANING
1	Successful minimization
-1	Internal error occurred within the minimization procedure (TNMIN)
-2	Minimization of the cost function did not converge - Maximum number of iterations (200) reached
-3	Minimization of the cost function did not converge – Minimum found at one edge of the admitted Spectral Shift interval
-4	Minimization of the cost function did not converge – Minimum found at one edge of the admitted FWHM interval

Meaning of the different Minimization Status values

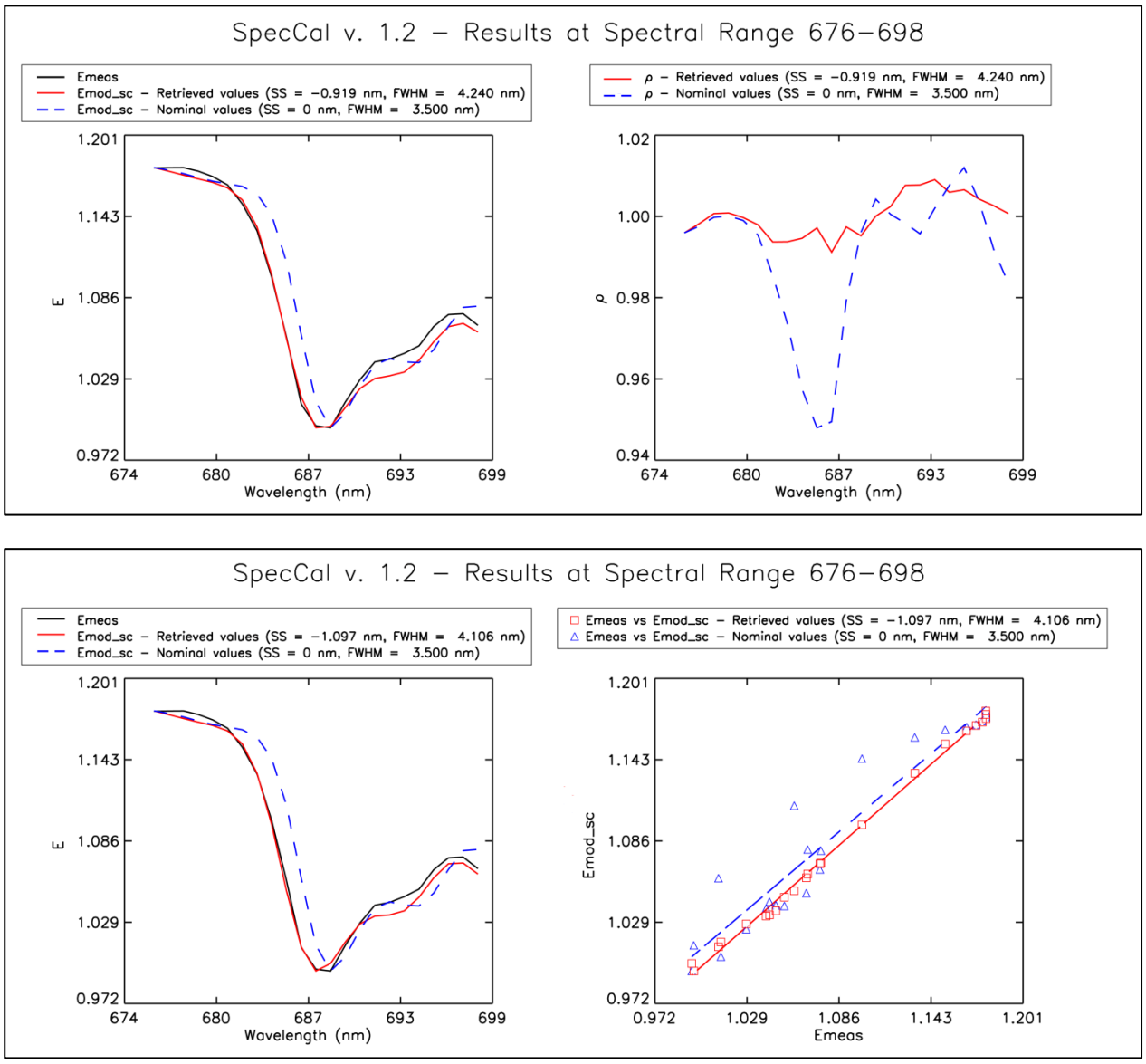
Success in the retrieval of spectral parameters is indicated by a Minimization Status equal to 1. A status of -1 indicates a fatal error occurred during the minimization, -2 signifies that the minimization did not reached convergence. In both cases, the user may try to solve the problem by modifying the spectral range considered using the Upper WL and Lower WL sliders. Statuses of -3 and -4 indicate that the minimum of the cost function was found at one edge of the SS or of the FWHM intervals among which the solution was searched. The user is advised to try to expand the searched intervals by increasing the SS or FWHM limits using the appropriate sliders in the "Computation Parameters" section of the GUI.

MESSAGE	MEANING
SpecCalCore Function: Spectral Sampling of Measured File not constant. Observations were linearly resampled with a SSI of XXX nm.	Issued if the SSI of the input Measured File is not constant. In this case, the input data is linearly resampled to a constant SSI equal to the minimum SSI found in the input Measured File
SpecCalCore Function: Maximum Iterations reached. Convergence not reached	Issued if the minimization algorithm failed to converge within the set maximum number of iterations. Associated with STATUS = -1
SpecCalCore Function: An Error occurred within the optimization algorithm (TNMIN) Convergence not reached.	Issued if the TNMIN minimization algorithm terminated with a Fatal Internal Error. Associated with STATUS = -2
TNMIN Function: Minimum error SS found at one of the edges of the admitted shift interval. Convergence not reached	Issued if the minimum of the cost function was found at one edge of the SS search interval. Associated with STATUS = - 3
TNMIN Function: Minimum error FWHM found at one of the edges of the admitted shift interval. Convergence not reached	Issued if the minimum of the cost function was found at one edge of the FWHM search interval. Associated with STATUS = - 4
SpecCal Core Function: Filter Half Width was GT nobs/5. It was set to nobs/5 = *XXX*	Issued if the number of channels included in the spectral range considered for the minimization is less than 25. In this case, the Half Width of the smoothing filter used for the Ratio method is reduced to N° of channels/5
Explore FWHM Function: Min FWHM lower than MODTRAN4 one. New min set to *XXX*	Issued if FWHM_nominal/FWHM limit is lower than the FWHM of the MODTRAN File. In this case, the minimum of the FWHM search interval is set equal to the FWHM of the MODTRAN File.
Explore Shift Function: The number of function evaluations was *XXX* and was set to 100.	Issued if the number of function evaluations to be used to identify the first guess for the Spectral Shift (Equal to the SS_Width/(SSI*0.25)) is less than 100. In this case, the number of evaluations to be performed is set to 100. The step used to explore the search interval is set to Range_Width/100.

Meaning of the different optional Messages

Output Plots

A graph showing the results of the spectral calibration is produced for each absorption window at which the spectral parameters were successfully retrieved.



Example of the output plots produced by SpecCal

The left panels of the plots show the comparison between the observed irradiance values (Eobs) and the simulated MODTRAN irradiance, resampled both to the nominal and to the retrieved SS and FWHM of the instrument and linearly rescaled between the minimum and maximum of the observed values in the spectral region considered (Emod_sc). The right panels show instead the data used for the computation of the minimization cost functions, at nominal and retrieved SS and FWHM values.

If selected, the data used to produce the plots are saved in semi column delimited CSV files located in the same folder of the Output Report File. The data reported in these files varies according to the method used for the calibration, and is explained below.

COLUMN N°	COLUMN HEADER	ASSOCIATED DATA
1	WL (nm)	Wavelengths
2	Emeas	Measured irradiance
3	Emod_sc – Retrieved Values	MODTRAN irradiance shifted and resampled to the retrieved SS and FWHM
4	Emod_sc – Nominal Values	MODTRAN irradiance shifted and resampled to the nominal SS and FWHM
5(*)	rho – Retrieved Values	Values of the rho ratio used to compute the cost function, computed using MODTRAN data rasampled to the retrieved SS and FWHM
6(*)	rho – Nominal Values	Values of the rho ratio used to compute the cost function, computed using MODTRAN data rasampled to the nominal SS and FWHM

Description of the different columns of the CSV files containing the data used to produce the plots.
(*) Columns 5 and 6 are produced only if the Ratio method is used.

Example Data

Measured Files

Example measured files acquired with the OceanOptics HR4000© and ASD HandHeld© high resolution spectrometers can be found in the "EXAMPLE_INPUT_DATA" sub-folder of the installation directory. Two files contain raw data expressed in counts, while the other two contain radiometrically-calibrated data, expressed in W m^{-2} ste^{-1} nm^{-1}. The main characteristics of these example files are reported below:

FILE NAME	Instrument	Measurement Units	SSI	Nominal FWHM	Location and date of measurement	Date of Factory Calibration
OO_RADIANCE.CSV	OceanOptics HR4000	Radiance (W $m^{-2}ste^{-1}\mu m^{-1}$)	0.25	1	Alpine Prairie - 2100 m a.s.l. 08/09/2009	16/05/2006
OO_COUNTS.CSV	OceanOptics HR4000	Counts	0.25	1	Alpine Prairie – 2100 m a.s.l. 08/09/2009	16/05/2006
HH_RADIANCE.CSV	ASD Fieldspec HandHeld	Radiance (W $m^{-2}ste^{-1}\mu m^{-1}$)	1	3.5	Po Alluvial Plane - 80 m a.s.l. 10/08/2009	13/06/2005
HH_COUNTS.CSV	ASD Fieldspec HandHeld	Counts	1	3.5	Po Alluvial Plane - 80 m a.s.l 10/08/2009	13/06/2005

Main characteristics of the example measured files.

MODTRAN Files

Two example MODTRAN irradiance files can be found in the MODTRAN_FILES sub-folder of the installation directory. . The main characteristics of these example files are reported below:

FILE NAME	Spectral Range (nm)	SSI	FWHM (nm)
SpecCal_modtran4sim350-800.csv	350 – 800	0.01	0.064
SpecCal_modtran4sim350-1000.csv	350 – 1000	0.01	0.1

Main characteristics of the example MODTRAN files.

The two files are representative of the solar incident irradiance observed in summer at middle latitudes in a clear-sky day, and present different spectral ranges and FWHMs (350-800nm with FWHM=0.064 nm and 350-1000nm with FWHM=0.01nm, respectively). The atmospheric parameters used for these simulations were the following: target at sea level, midlatitude summer atmospheric model, rural aerosol model, 23 km visibility, 30° solar zenith angle, 0° solar azimuth angle, DISORT 8

streams scattering option, 1 cm^{-1} MODTRAN band model and corrected Kurucz database for the solar top of atmosphere irradiance.

The example MODTRAN files can be used for analysis of the example measured files, but also to perform spectral calibration of user-supplied data. **The proper spectral calibration of spectral data acquired in conditions strongly different from that considered for the creation of the example files may require the availability of a more representative simulated irradiance file**.

Output Data

The results obtained by applying the spectral calibration procedure to the example files using the computation parameters specified below and exploiting both the Ratio and Correlation methods can be found in the "EXAMPLE_OUTPUT_DATA" sub-folder of the installation directory. The "SpecCal_modtran4sim350-1000.csv" MODTRAN file was used, and the lower and upper wavelengths of the absorption windows were kept at default values.

Measured File	Measurement Type	Target Reflectance	Measurement Units	SS Limit	FWHM Limit	RW
OO_RADIANCE.CSV	Reflected Radiance	Optopolymer_50_50.csv	Physical Units	2	2	10
OO_COUNTS.CSV	Reflected Radiance	Optopolymer_50_50.csv	Counts	2	2	10
HH_RADIANCE.CSV	Reflected Radiance	Optopolymer_50_50.csv	Physical Units	2	3	10
HH_COUNTS.CSV	Reflected Radiance	Optopolymer_50_50.csv	Counts	2	3	10

Input files and computation parameters used for the processing of the example measured files.

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