MobileDOAS

Software Manual

Version 5.0

November 2009

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Sweden

1. OVERVIEW

The software MobileDOAS described in this user manual is a software package developed by Chalmers University of Technology in Sweden as an easy to use software package for performing gas flux measurements using the mobile DOAS technique.

The software is tested with the following spectrometers from Ocean Optics Inc.:

S2000	USB2000+
USB2000	USB4000
HR2000	HR4000

DEVICES

1. *Spectrometer* – Collect spectra;
2. *GPS receiver (with USB interface)* – Record GPS time and GPS coordinates;
3. *USB cable* – Communication with and power to the spectrometer.
4. *Fiber and telescope* – Connected to the spectrometer to expand the visible scope;
5. *Laptop or desktop computer* – Run the program to collect data from the spectrometer and GPS receiver.

Note: Before running the software, please make sure that the equipment is properly connected to the computer.

SOFTWARE REQUIREMENT

- CPU - Pentium III 550 MHz or higher
- Memory - 128 MB or more
- Operating system - Windows 2000, Windows XP or Windows Vista
- Screen Resolution - preferably at least 1024 by 768 pixels

INSTALLATION OF MOBILEDOAS VERSION 4.X (DEVELOPED 2005 TO OCTOBER 2009)

Copy the files: MobileDOAS.exe, OOIDrv32.dll and cfg.txt into a folder to which you have write access. Click the MobileDOAS.exe to start the program.

The file OOIDrv32.dll can also be put in the System-folder in the Windows-folder.

INSTALLATION OF MOBILEDOAS VERSION 5.X (DEVELOPED OCTOBER 2009)

As of version 5.0, MobileDOAS is installed using a special installation program. This will also install Java Runtime (version 1.6) if this is not already installed on the computer. The Java Runtime package is necessary for the measurement to function.

2. PERFORMING FLUX MEASUREMENTS USING MOBILEDOAS

To perform a flux-measurement using MobileDOAS the equipment mentioned on page 4 is necessary and must be connected to a computer running MS Windows.

Before starting the measurement, MobileDOAS must be configured as explained below. The measurement starts with setting the exposure-time of the spectrometer and the telescope must therefore in the beginning be pointing to the zenith. Once the exposure-time is set, the number of exposures to add before storing one spectrum is calculated based on the desired time-resolution and the calculated exposure-time. The dark-current of the spectrometer detector is then measured at the set exposure-time; to do this the entrance of the telescope must be covered. When the dark-spectrum is measured, the program measures one "sky" – spectrum, which is also sometimes referred to as Fraunhofer-reference or control spectrum. This is the reference spectrum to which all the evaluated column values will be relative, hence if this spectrum contains pollutants such as SO_2 then the evaluated column values can be negative.

Each measured spectrum after the sky-spectrum is evaluated, using the dark and the sky-measurements and the result is shown in the main-window and also appended to the evaluation – log file in the output folder. The measured spectra, including the sky and the dark spectra, are also stored in the output – folder.

COLLECTING SPECTRA

STEP 1 - CONFIGURATION

Before running the program it is necessary to set some configuration parameters.

Click menu "Configuration → Operation Setting" or click  on the toolbar.

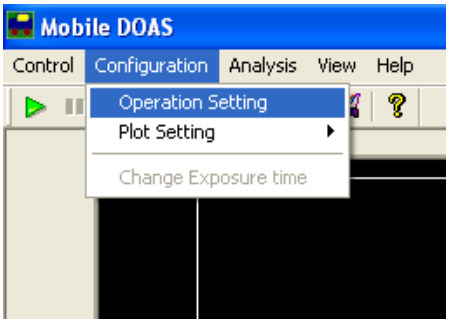

FIGURE 1. THE SETTINGS FOR MOBILEDOAS CAN BE FOUND BY CLICKING ON "OPERATION SETTING".

The "Configuration Dialog" will pop up. The settings in the configuration dialog are taken from the *cfg.xml* (this is only for version 4.4 or newer, in the older versions are the settings read from *cfg.txt*) in the working folder.

The dialog is separated into the following three pages (these are further explained below)

- **Spectrometer** – here you can configure how to connect to the spectrometer and how to set the exposure time of the spectra.
- **GPS** – here you can configure how to connect to the spectrometer
- **Evaluation** – here you can configure how to evaluate the collected spectra.

When you are done with the settings then press the button "Save" to store the settings to *cfg.xml* or press "Cancel" to close the dialog without writing anything to file.

THE SPECTROMETER PAGE

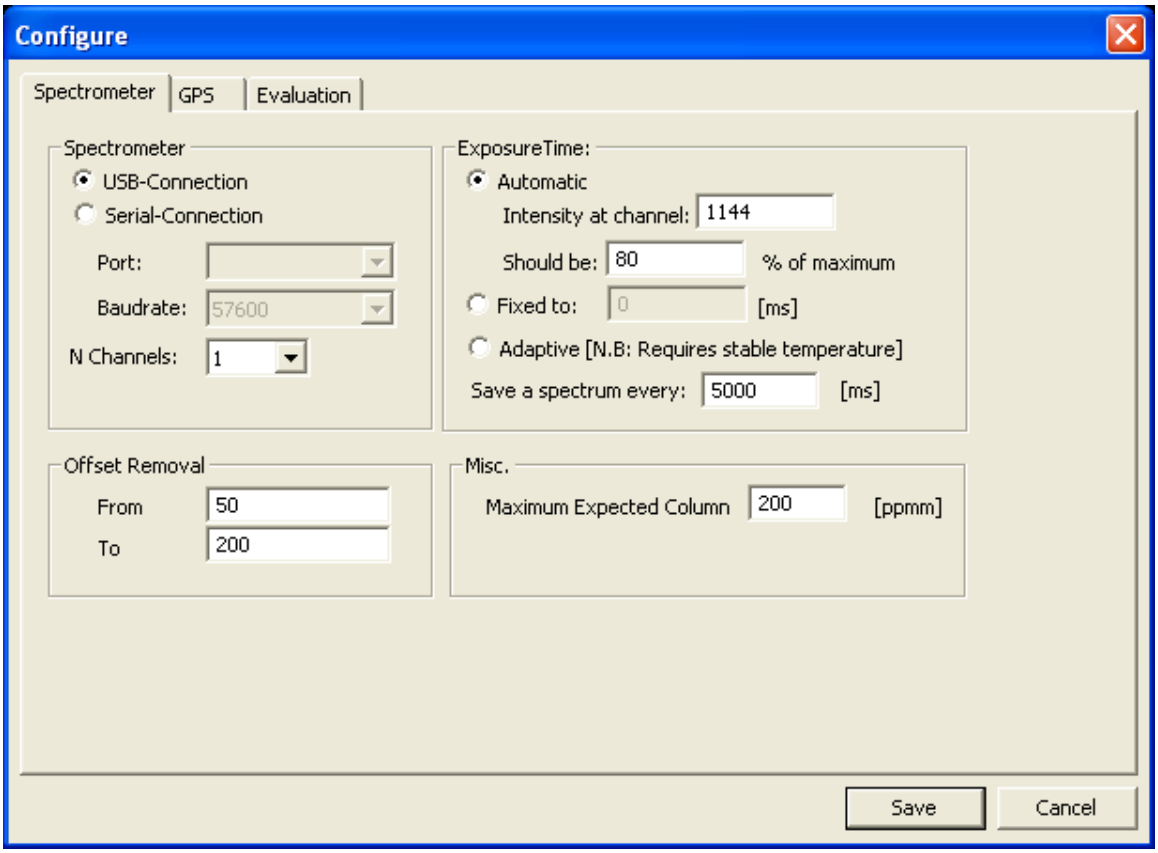

FIGURE 2. THE SPECTROMETER PAGE IN THE CONFIGURATION DIALOG.

This page is divided into the following groups:

- **Spectrometer Setting** – Choose "USB" if an USB-cable is used for communicating with the spectrometer. If the serial port is used, select the correct COM port and baud rate for the spectrometer. Also select the number of channels that you wish to use on the spectrometer.

- **Exposure Time** – It is possible to set the exposure time manually or let the program calculate it automatically from the received level of light.

    - **Automatic (recommended)** If this is set, then the exposure time will be calculated when the sky spectrum is collected, in the beginning of the measurement. This exposure time will then be used for every collected spectrum in the measurement. The calculation is based on the values in the two edit boxes. The first specifies pixel on the spectrometer's detector where the light-level will be measured. The second is the desired saturation ratio at that pixel.

    - **Fixed** You can also manually set the exposure time to use in the measurement. This exposure time will be used for every collected spectrum in the measurement.

    - **Adaptive (advanced):** It is also possible to let the software calculate the optimal exposure time for each spectrum in the measurement. This gives better quality spectra but requires an absolutely stable temperature of the spectrometer. ONLY USE THIS IF YOU REALLY KNOW WHAT YOU ARE DOING. Notice that when selecting adaptive exposure time the program will start the measurement by collecting a dark-current and offset spectrum – which can take 5 – 10 minutes.

- **Offset Removal**. The software calculates and subtracts an offset from each spectrum with the purpose of reducing stray light and compensate for a changing offset. These values should be a range of pixels which you know should be dark (i.e. covering wavelengths where there really is not supposed to be any light). If you are using a S2000 or USB2000 spectrometer covering the wavelength range 280 to 420 nm then these values should be 50 and 200.

- **Misc.** To make it easier to make measurements alone, the software can play a sound for each measured column with increasing volume for high measured gas columns. The value to enter under 'Maximum expected column' is the maximum value that you expect to have in a measurement. Measured values at this column or higher will be played at the maximum sound volume.

THE GPS PAGE

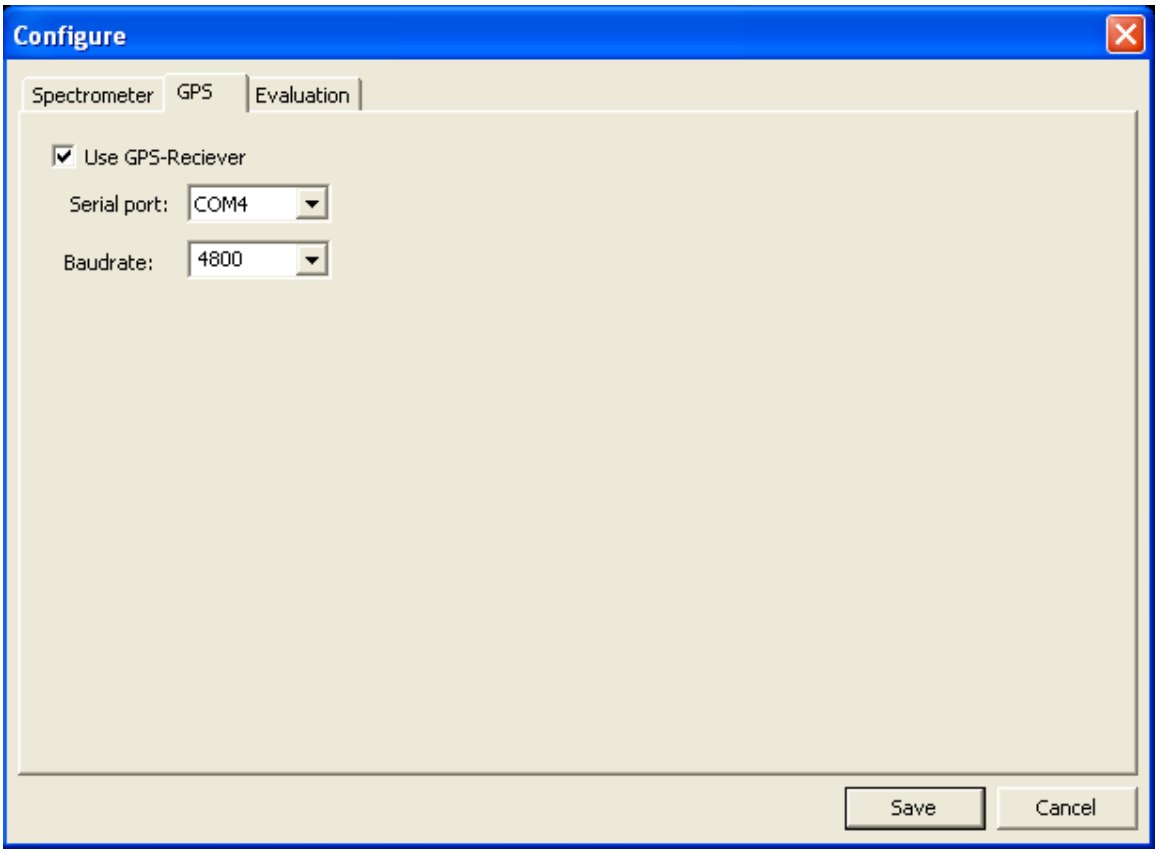

FIGURE 3. THE GPS PAGE IN THE CONFIGURATION DIALOG.

If you use GPS receiver, the checkbox of "Use GPS Receiver" should be clicked. The COM port and baudrate (usually 4800 bps) should be chosen according to the GPS receiver. **Note: if the GPS is not used then no flux can be calculated from the measurement!**

THE EVALUATION PAGE

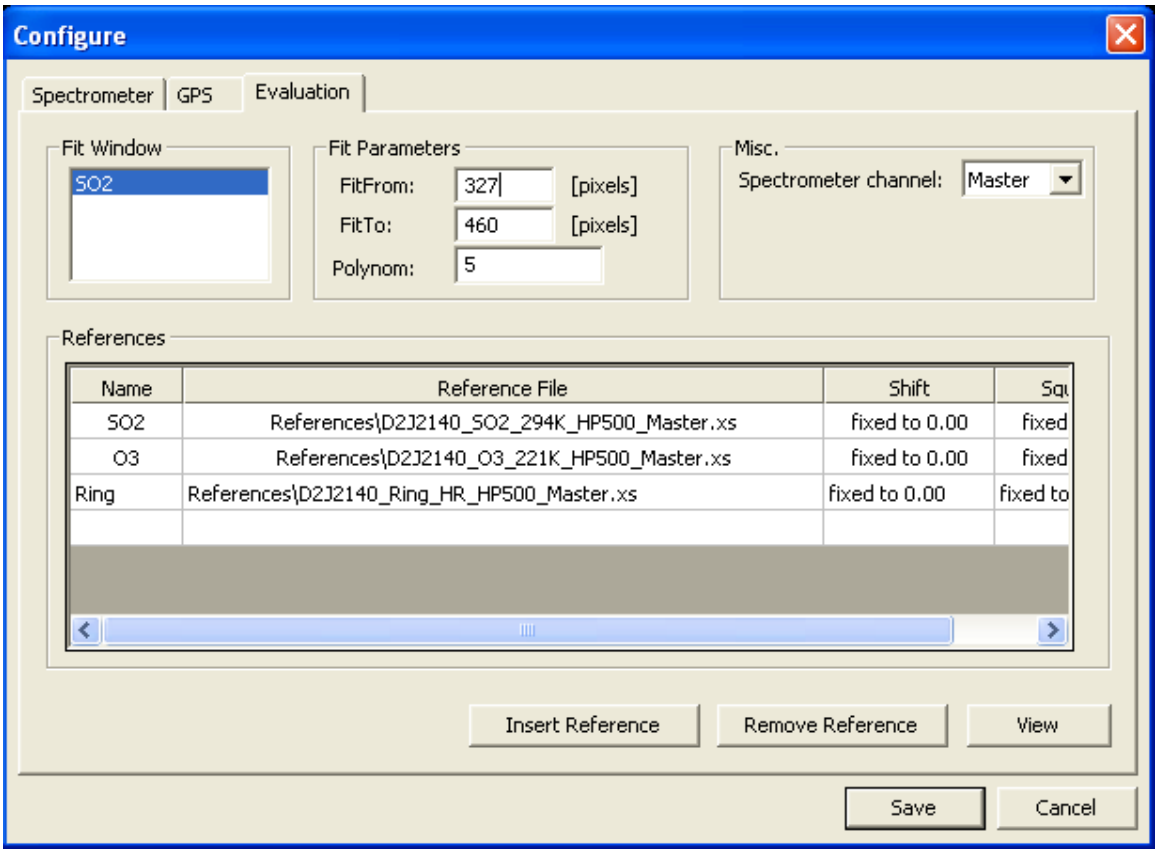

FIGURE 4. THE EVALUATION PAGE IN THE CONFIGURATION DIALOG.

To derive the gas columns from the measurement you need to specify at least one reference file to use in the evaluation. If you don't know which file to use or which range of pixels to use, ask the supplier of your mobile DOAS system.

You should first specify the range of pixels to use for the evaluation, this is done in the two edit boxes 'FitFrom' and 'FitTo'.

If you have not specified any reference files (that is; you don't see anything in the box with references) then press the 'Insert Reference' button in the lower part of the page. This will open a dialog that makes it possible to select a reference file to use. If you wish to change the setup then select the reference file you wish to remove in the list and press the button 'Remove reference'. You can specify any number of references that you wish in the list of references but only the fit result of the first one will be shown on the screen when making a measurement.

You can check the reference files that you have specified by pressing the button 'View', this will open the reference file dialog (see Figure 5). In this dialog you can see the size of the

reference files over the range of pixels specified by FitFrom and FitTo. If you don't see any red line in the graph, then you should check your reference files.

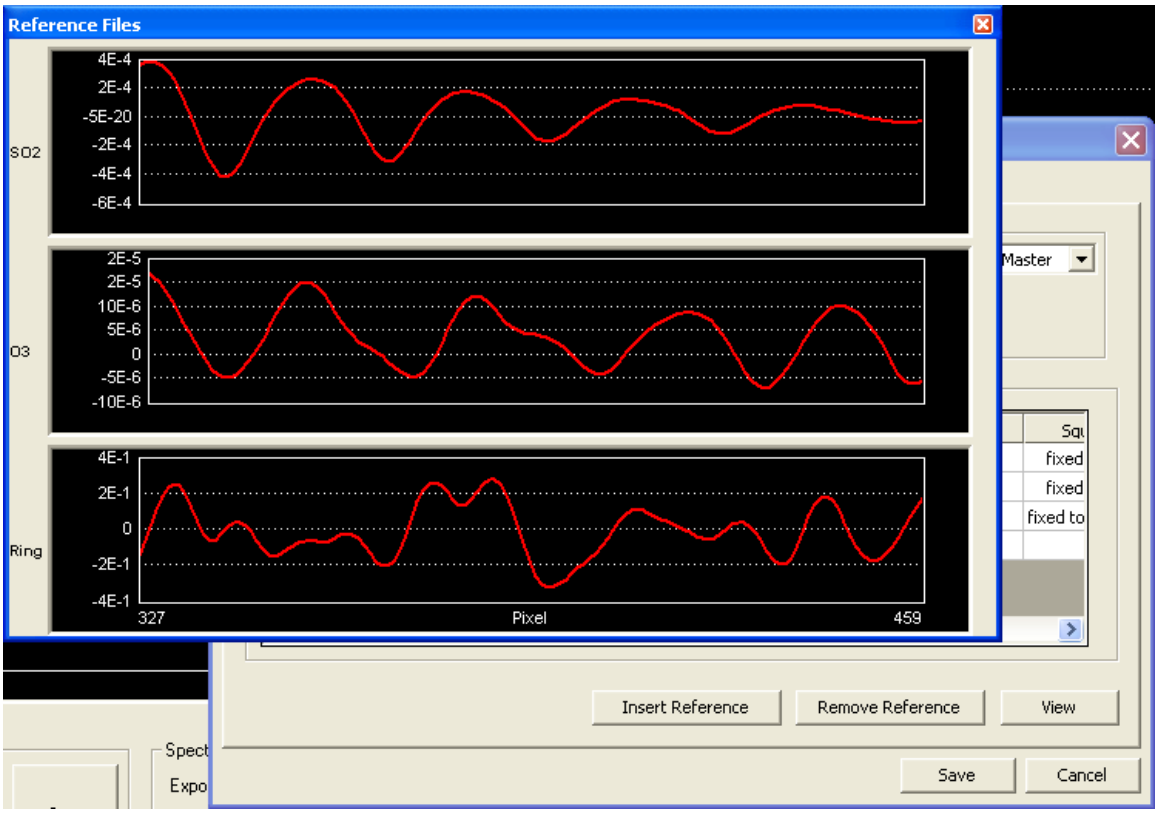

FIGURE 5. THE REFERENCE FILE DIALOG AS OPENED FROM THE CONFIGURATION DIALOG. TO THE LEFT ARE THE NAME OF THE REFERENCE FILES SHOWN AND THE GRAPHS TO THE RIGHT SHOWS THE SIZE OF THE REFERENCES OVER THE SELECTED FIT RANGE.

Click "Save" to save the new configuration or "Cancel" to close the dialog without saving anything.

STEP 2 – INITIAL SETTING

After you check the configurations, you can set wind speed, wind direction and base name for the measurement in the main window. The wind speed and the wind direction parameters are used by the real-time calculation of flux. So if you are not sure about the wind speed and the wind direction, you can leave them as the default values.

The base name is the name you give to the measurement and is used when saving the spectra.

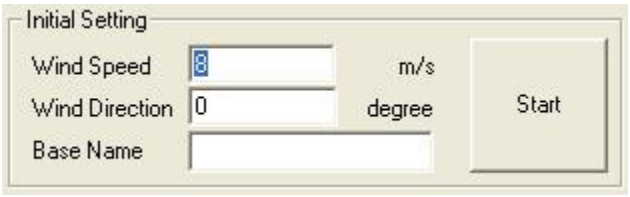

FIGURE 6 - INITIAL SETTING IN THE MAIN WINDOW

STEP 3 – START DATA COLLECTION

Click button "Start" (shown in Figure 5.3 Initial Setting) or click  in the toolbar to start data collection.

You can also start data collection by clicking menu "Control → Start Traverse".

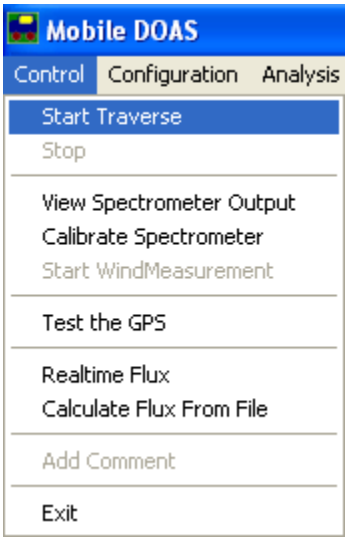

FIGURE 7 - START THE DATA COLLECTION BY PRESSING START TRAVERSE IN THE MAIN MENU.

When the data collection starts, the program tests the connections to determine if the spectrometer and GPS are connected to the computer. The software creates a folder with the name of the current date (taken from the computer's time) inside which all measurements will be stored, with one sub-folder for each measurement performed. The program stores the collected spectra as .STD-files and it creates one evaluation-log containing the results of the evaluations.

RESULTS SHOWN IN REAL-TIME

To make sure that the data-collection runs as it should, the MobileDOAS program shows running information which makes it possible to inspect the collection of data.

THE MAIN WINDOW

The main-plot in the main-window shows the evaluated columns of the last measured spectrum (by default as red columns), the intensity of the last spectrum (by default as white squares) and the last spectrum measured (by default as a green line for the master-channel of the spectrometer and as a red line for the slave-channel of the spectrometer, if one exists).

In the lower part of the main-window, additional information about the collected spectra is shown. The 'Spectrometer Information' – panel shows the following information about the last measured spectrum

- The exposure time, in milliseconds
- The evaluated column and the column error, in ppmm
- The shift used in the evaluation, normally 0
- The number of spectra measured and saved so far
- The number of exposures which are co-added in the last measurement
- The squeeze used in the evaluation, normally 1

The 'GPS-Information' – panel shows the following information about the last reading from the GPS-receiver

- GPS-time, in UTC
- Latitude, in degrees with negative values in the southern hemisphere
- Longitude, in degrees with negative values in the western hemisphere
- #Satellites – the number of satellites that can be seen by the GPS-receiver. A minimum of three is required for the calculation of latitude and longitude.

If the GPS – receiver looses the connection with the satellites, the 'GPS-Information' - panel will give a warning by turning red.

THE REAL-TIME ROUTE GRAPH

The real-time route graph can be opened from the menu in the main window through the menu option 'View→Real-time Route'. If there is a GPS-receiver connected to system, then the real-time route window shows the location of the so-far collected spectra in a latitude-longitude plot.

THE SPECTRUM-FIT WINDOW

The Spectrum-fit window can be opened from the menu in the main-window through 'View→Spectrum Fit'. The spectrum-fit window shows the last differentiated measured spectrum together with a scaled cross-section provided from the given reference-file. This can be used to visually inspect the quality of the DOAS fit.

THE COLUMN ERROR

Optionally, the error bars of the retrieved columns can be shown in the real-time graph. The menu option 'View→Column Error' toggles the error bars on or off. The graph will be updated when the next spectrum is collected.

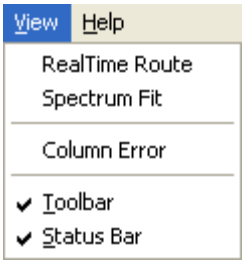

FIGURE 8 – VIEW MENU IN THE MAIN WINDOW.

CHANGING THE EXPOSURE TIME

The exposure time of the spectra is set when the program is started either by the user or automatically by the program. If the amount of incident light increases or decreases drastically, e.g. by changing weather conditions, the exposure-time can be changed on the fly without restarting the program. To change the exposure time while collecting spectra, select from the menu in the main-window the option "Configuration→Change Exposure Time". This will send a message to the program to change the exposure-time. When the exposure – time has changed, the user should take a new dark measurement as soon as possible since the dark-current is strongly depending on the exposure time used.

3. FLUX CALCULATION

FLUX FORMULA

The flux is calculated using the measured gas columns, the spatial distance between two sample points, the wind speed and the wind direction. The formula is:

$$Flux = column * distance * wind\ speed * wind\ factor$$

The wind factor is calculated by the travel direction and the wind direction.

$$Wind\ factor = \cos(travel\ angle - wind\ angle + 3\pi/2).$$

The flux can be calculated in two ways, either in real-time directly from the measurement or off-line after the measurement has been done. The real-time calculation does not allow for any inspection of the data used and should only be used to give an indication of the size of the flux.

REAL-TIME FLUX

During the measurement you can check the real-time flux. Select the menu option "Control→Realtime Flux", the flux value will be shown. The real-time flux calculation uses the raw column values and the wind speed and wind direction that was given when the measurement started.

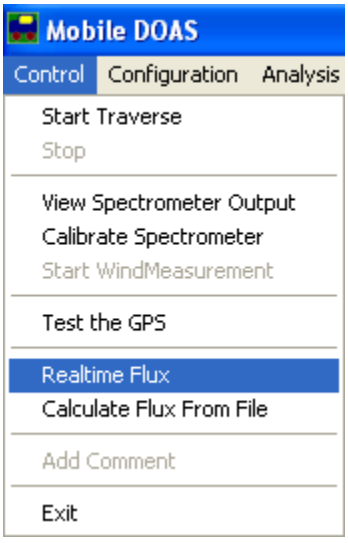

FIGURE 9 - MENU – REAL TIME FLUX

CALCULATE FLUX FROM FILE

After the measurement is finished you can calculate the flux using the post flux calculation dialog in MobileDOAS. Click on the menu "Analysis→Calculate Flux From File" or click on the button  on the toolbar to open the "Post Flux Calculation" dialog.

STEP 1 – SET WIND PARAMETERS AND SOURCE COORDINATE

First open the evaluation log file from the measurement you want to process by pressing the button "Open Log File(s)" in the upper right corner of the dialog. The program will now read the data in the evaluation log file and show some data on the screen.

In the small list-box just below the "Open Log File(s)" button you can see which log files are currently opened and select which one to process. The main graph in the dialog shows the columns from the currently selected measurement. Notice that when a measurement has been evaluated with several references (e.g. SO_2 and O_3) then this will be listed as two or more evaluation logs – each one starting with the name of the trace gas. Make sure that you select the trace gas you wish to calculate the flux for!

To calculate a flux, you need to fill in the wind speed and wind direction (in degrees) at the time of the measurement in the white boxes below the evaluation log list.

MobileDOAS can also calculate a wind direction for you. If you wish use this feature then you need to supply the latitude and longitude of the source. The wind direction is then calculated as the direction of the line directly from the source to the point where the centre of the gas plume is found.

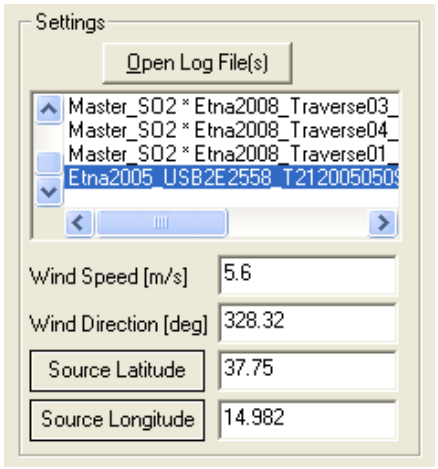

FIGURE 10 - POST FLUX CALCULATION SETTINGS. THERE IS ONE LINE FOR EVERY REFERENCE THAT WAS INCLUDED IN THE EVALUATION OF THE SPECTRA. MAKE SURE THAT YOU SELECT THE SPECIE YOU WISH TO CALCULATE THE FLUX FOR.

The wind-speed and wind-field can also be imported from a text-file, see page 20.

STEP 2 – DELETE BAD POINTS

Check the column plot to see whether there are any "bad points". The "bad points" are spectra with very low or very high intensity and are usually caused by trees or buildings which are blocking the light to your telescope during the measurement or by bright clouds sending too much light into the telescope. An example of a measurement with bad points can be seen in Figure 11.

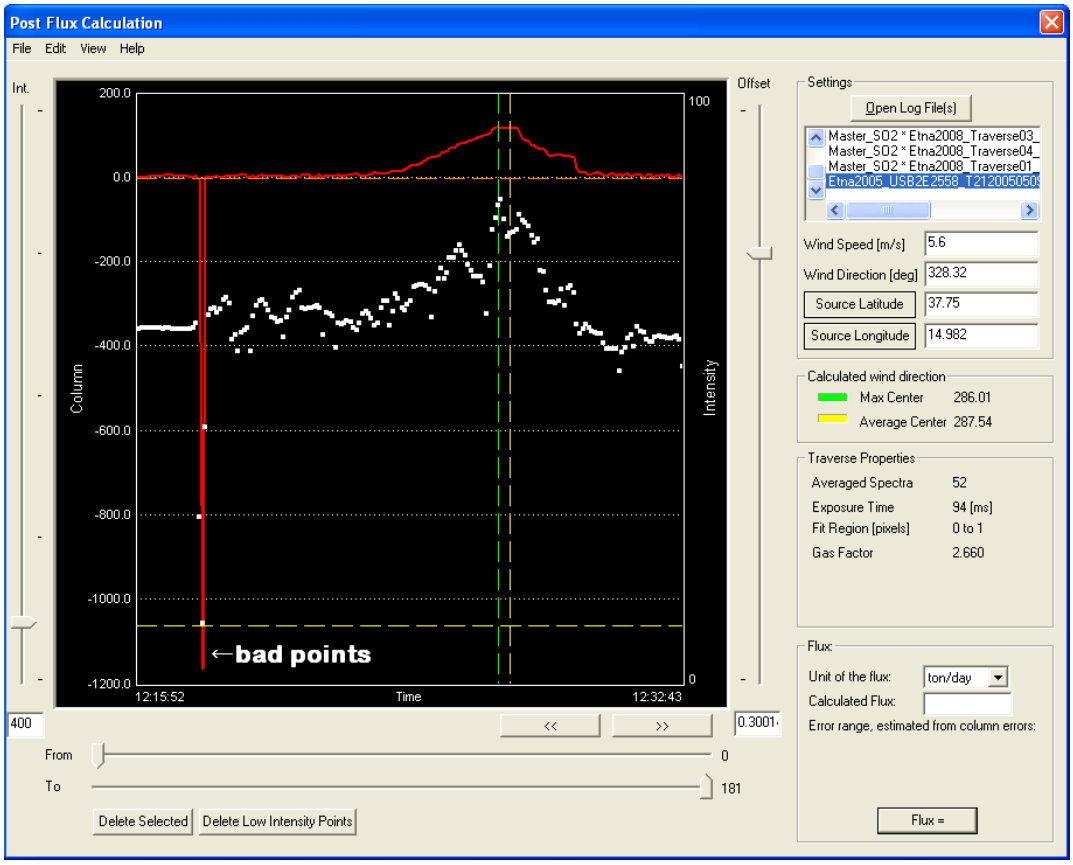

FIGURE 11.A MEASUREMENT WITH THREE BAD POINTS OPENED IN THE POST FLUX DIALOG.

In the column plot you can also see the intensity of each spectrum plotted as white squares and the error in the derived gas columns.

> *If you cannot see the white squares use the menu-item 'View→Show Intensity' or right-click on the graph and select 'Show Intensity' to show the white squares. You can also see the error of each derived gas column in the plot by selecting 'View→Show Column Error' or right clicking in the graph and selecting 'Show Column Error'.*

A "bad point" can be either a very low or very high concentration value, which introduces very large errors into the flux calculation.

The “bad points” can be deleted in two ways:

- By index: Use the “From” slider and “To” slider to enclose the location of the “bad point”, note that points which are not in the selected range will be grayed out. The indices at which the ‘From’ and ‘To’ sliders are pointing is shown to the right of each slider. Clicking the button “Delete Selected” will delete the points between the two sliders.

- By intensity: Use the “Int.” slider on the left hand side of the window to define a limit on the intensity of the spectra, when you click the button “Delete Low Intensity Points” all measurements with intensity lower than the defined will be deleted and a message box will inform you of the number of points deleted.

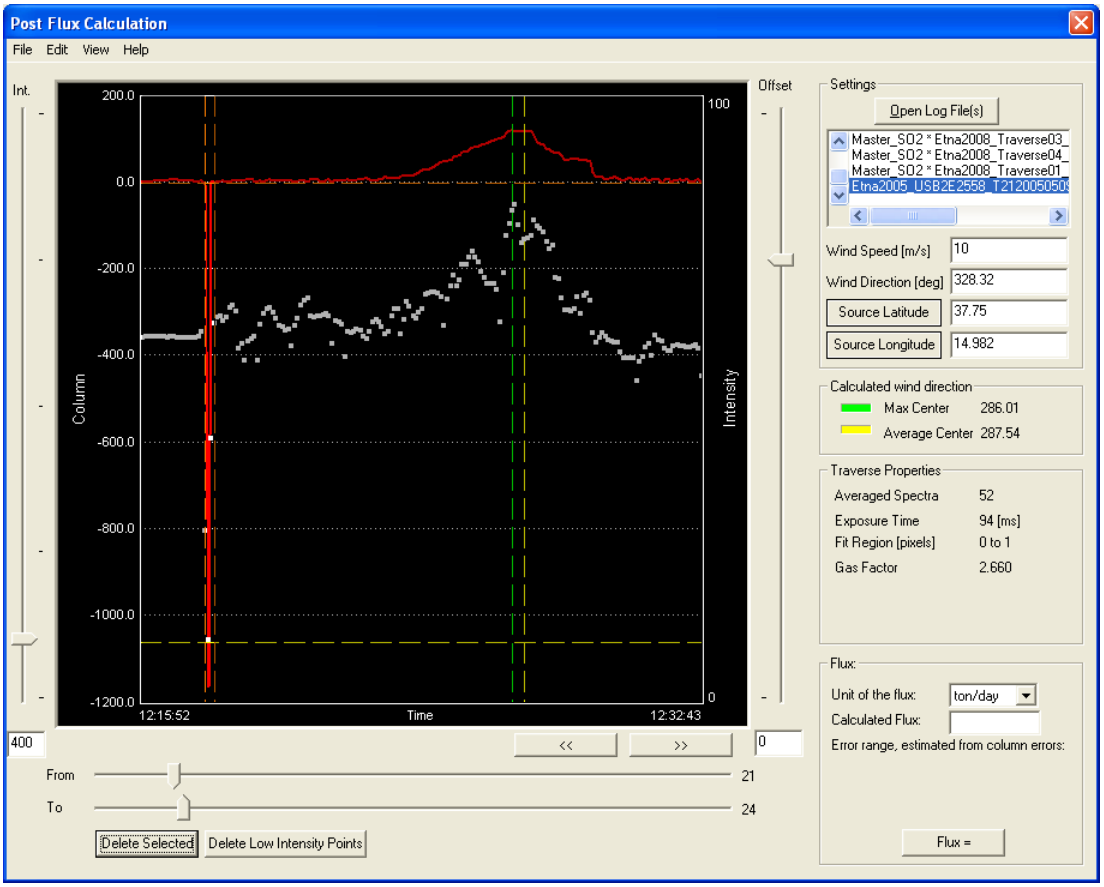

FIGURE 12.SAME MEASUREMENT AS IN FIGURE 11, WITH THE THREE BAD POINTS SELECTED WITH THE ‘FROM’ AND ‘TO’ SLIDERS.

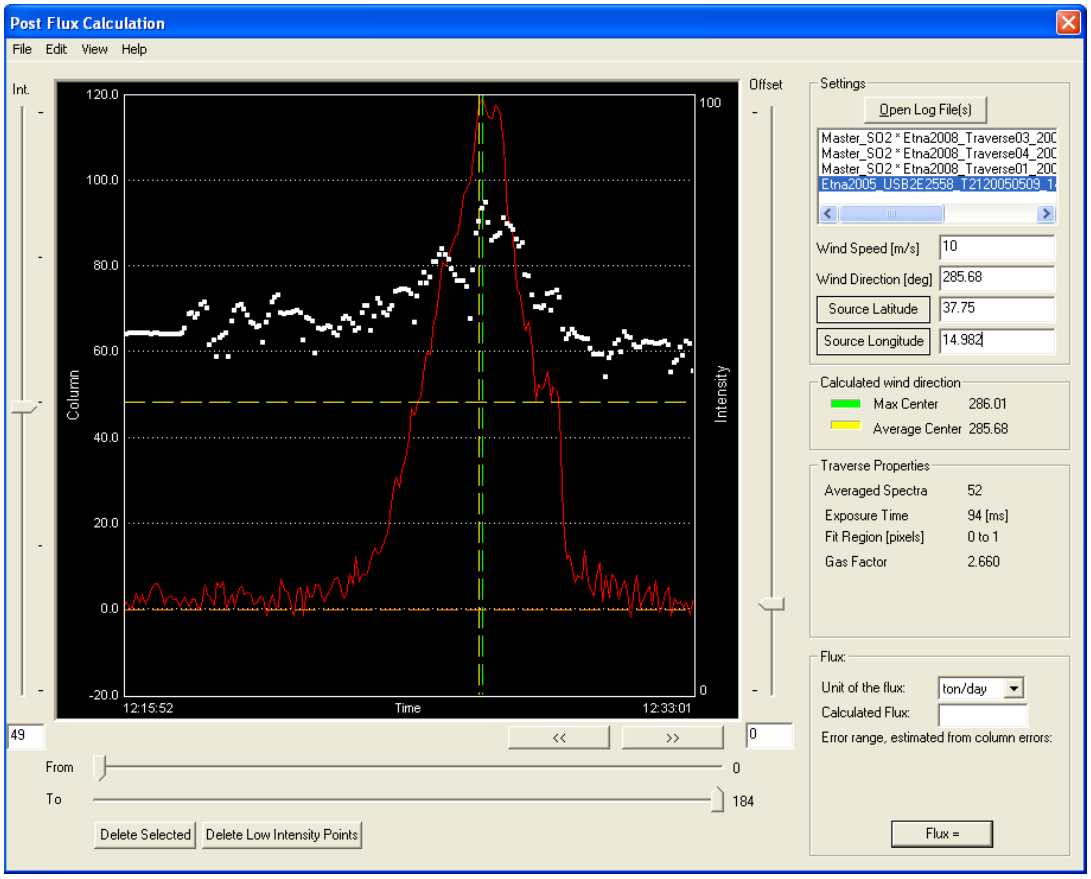

FIGURE 13.SAME MEASUREMENT AS IN FIGURE 11 AND FIGURE 12 AFTER THE BAD POINTS HAVE BEEN DELETED.

STEP 3 - CALCULATE FLUX

Move “From” and “To” sliders to enclose the scope where you want to calculate flux. If the traverse is very long, not all measurements will be shown in the plot. You can then move the plot using the buttons 

. Move the “Offset” slider to set the column offset for flux calculation. Usually the offset value can be set to the lowest column value. Select the unit you want to have the flux in then click the button “Flux = ” to get the flux result. After the calculation the program generates a log file called *fluxCalculation.txt* which locates in the same place with the evaluation log file.

IMPORTING A MODELED WIND-FIELD

In cases where the traverse extends over a larger area a modeled wind field can give a more accurate result. The modeled wind fields can provide a different wind-speed and wind-direction for each measurement point. To import the result from a model, open the evaluation log for which the flux shall be calculated in the post-flux dialog and press 'Edit→Import Wind field' from the menu in the post-flux dialog. This will open the 'Include Wind field' dialog (see Figure 14). The text-file containing the modeling can be selected by pressing the 'Browse' – button. If the file contains data for several altitudes and times then the two combo-boxes in the left side of the dialog will contain all altitudes and hours for which the data is valid. Selecting a combination of one altitude and one hour will display the wind-field in the graph in the 'Include Wind field' dialog. The wind field is displayed as lines pointing to the direction in which the wind comes from and the relative length of each line shows the strength of the wind at that point compared to the other points.

Finally, pressing the 'Use' button in the lower part of the dialog will import the data from the wind-field to the currently selected evaluation log.

Note:

- Only the data for the altitude selected in the 'Altitude' combo-box will be used
- The time of the measurement will be compared to the time of the data points in the wind field and the correct time will be chosen automatically
- If a measurement point does not exactly correspond to any point in the wind field file then the closest point will be selected
- The time-stamp for each wind data-point can only be an integer hour. Measurements made in between two integer hours will be interpolated in time. E.g. for a measurement made at 13:25 the wind field will be an linear interpolation between the wind-field at 13:00 and at 14:00

For a detailed description of the format of the files that can be imported, see page 44.

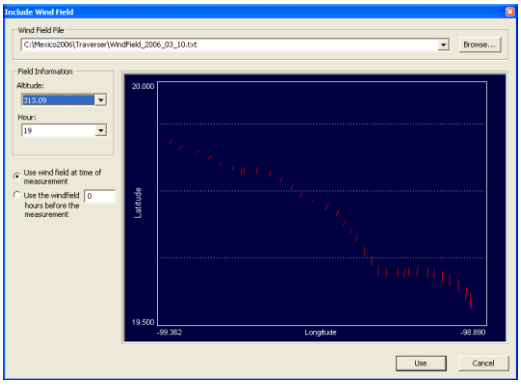

FIGURE 14 – THE 'INCLUDE WIND FIELD'DIALOG.

4. RE-EVALUATION OF SPECTRA

If the real-time evaluation of the spectra was not adequately good, the spectra can be evaluated again by using the spectrum ReEvaluation module of MobileDOAS. There are many options for how to re-evaluate a measurement. The options are organized into tabs in the ReEvaluation – dialog. For most re-evaluations, the values already filled in when the dialog is opened are ok.

The ReEvaluation-dialog is reached by:

- The menu in the main-window by selecting 'Analysis→ReEvaluate Traverse'
- By pressing the button  on the toolbar
- In version 4.1 or earlier of the MobileDOAS is the ReEvaluation dialog found under 'Control→ReEvaluate Traverse'.

NOTE: In older versions of MobileDOAS are there two buttons "OK" and "Cancel" in the bottom part of the ReEvaluation dialog. Pressing these buttons will close the window without saving your settings or evaluating any spectra.

STEP1 – SELECTING THE EVALUATION LOG

The first step is to select the evaluation-log from the performed measurement. The evaluation-log should stay in the same directory as where it was created, i.e. in the same directory as all the spectra in the measurement. The evaluation log is selected by pressing the 'Browse' button in the 'Evaluation log' top part of the dialog, as shown in Figure 15. When the evaluation-log is correctly opened, the measured columns in the log-file will be shown in red in the plot in the lower left part of the dialog – as shown in Figure 15.

It is possible to view the spectra in the measurement by pressing the button 'View Spectra', more about this on page 31.

There are several groups in the first page, their function is as follows:

Dark Spectra — Here it is possible to select if some spectra shall not be evaluated. For example, spectra with very low intensity will give very bad values, and it can therefore be justified to ignore some measurement points already in the evaluation instead of removing them later, in the post-flux calculation. There are three options:

- **Ignore completely dark spectra**. Only spectra where there is no light whatsoever will be ignored.
- **Ignore Spectra with Intensity below:** Lets the user select the channel at which the intensity should be judged and a desired threshold intensity for ignoring spectra.

- **Ignore the Following Spectra:** If the user knows the indices of some spectra that should be ignored, their indices can be typed into the edit-box as a comma, or space separated list.

Saturated Spectra

Similar to the 'Dark Spectra' box above, but here the user can select to ignore spectra with too much light. Spectra with too high light-level are saturated and does not contain any information in the saturated regions. The user has here the possibility to specify a pixel/channel to judge the intensity and the desired maximum level of intensity that should be allowed at that pixel/channel. **Saturated spectra will only be ignored if the checkbox is checked.**

Wavelength range

In the evaluation of a spectrum, the spectra will automatically be corrected for stray-light using a simple heuristic method. This correction is different if the spectrum starts in the deep UV-region or in the (near) visible region. **Select the 'UV' – radio button of the spectrometer starts at a wavelength of 300 nm or less.**

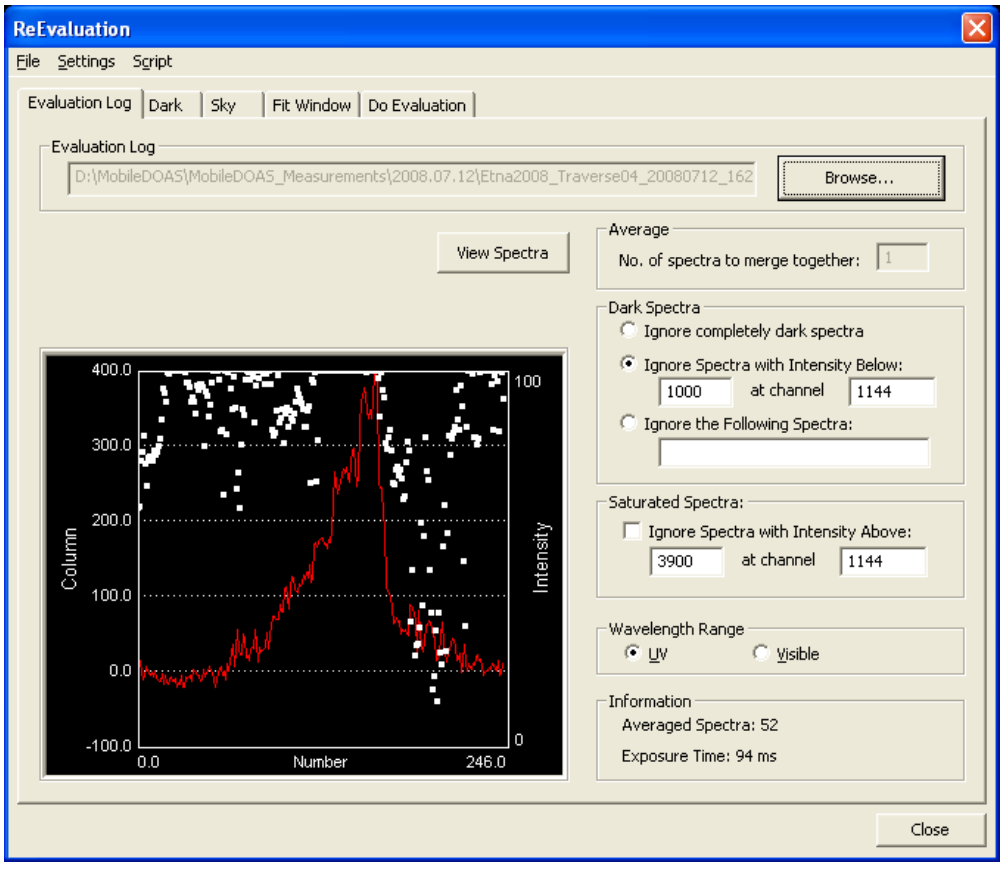

FIGURE 15 - SELECTING THE EVALUATION - LOG FOR RE-EVALUATION.

STEP2 – THE DARK SPECTRUM

The second step is to specify if there are one or several dark-spectra in this measurement.

If there is only one dark spectrum in the measurement, all measured spectra will be corrected for dark-current using this dark-spectrum.

If there are several dark spectra in the measurement, the measured spectra will be corrected for dark-current using an interpolation of the measured dark-spectra. This can improve the quality of the evaluation.

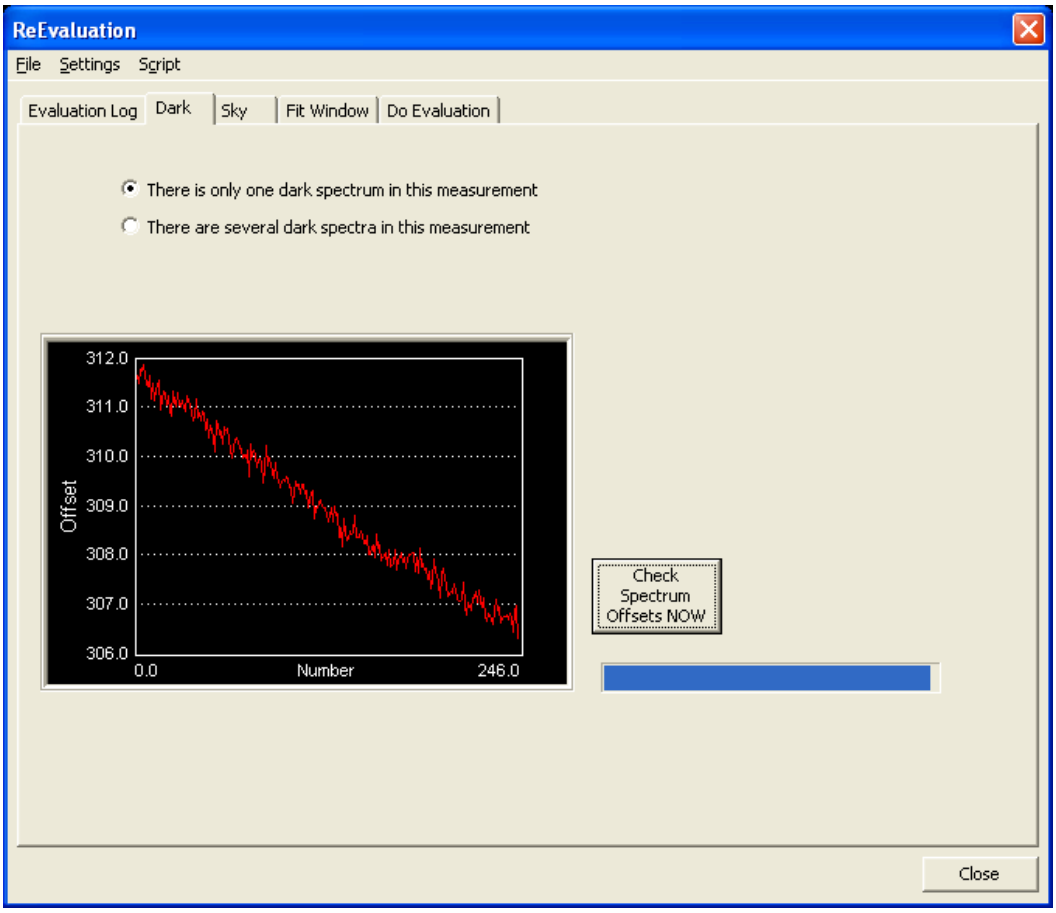

FIGURE 16 THE 'DARK' PAGE IN THE REEVALUATION DIALOG.

STEP3 – THE SKY SPECTRUM

The measurement is evaluated using one spectrum as 'sky'-reference. This spectrum is used to remove Fraunhofer-structures in the measured spectra, and all evaluated values will be relative to this spectrum. The sky-spectrum can be selected in several ways, and the different options will give different qualities of the resulting measurement value.

- **Use fist spectrum as sky reference** – The default option, this is also the behavior for the real-time evaluation.
- **Use average of all spectra as sky reference** – An average value of all spectra will be used as sky reference. This can improve the quality of the fit, if all spectra in the measurement are good.
- **Use all spectra which fulfill:** An average of all spectra with intensities within the given limits and with (real-time) evaluated column values within the given limits will be used as sky-reference. This can improve the quality of the fit, if the limits are chosen wisely.
- **Use the following spectrum:** A specified spectrum will be used as sky-reference. This can improve or worsen the fit, depending on which spectrum is chosen. This can make it easier to compare several measurements.

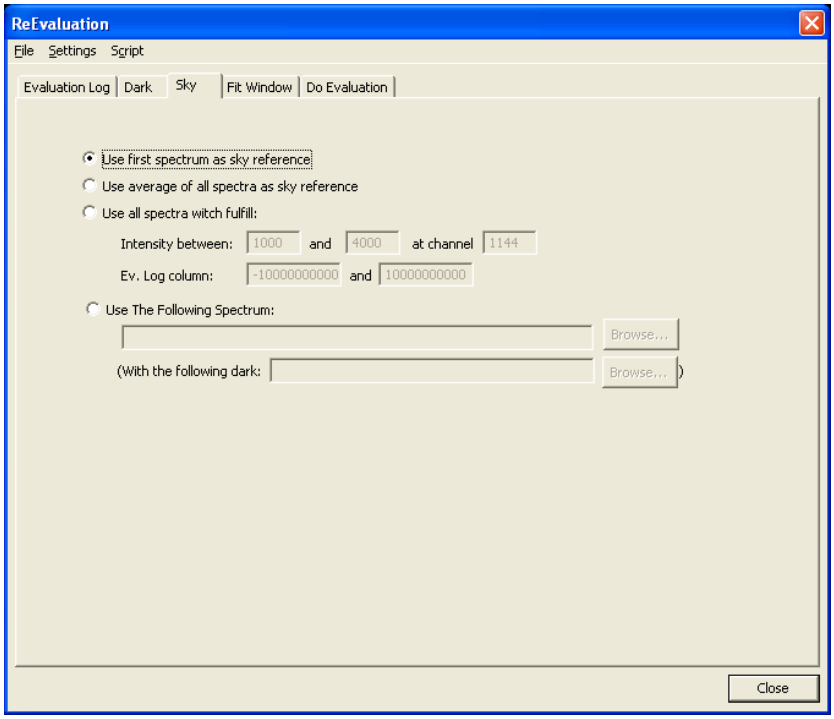

FIGURE 17 - THE 'SKY' - PAGE IN THE REEVALUATION DIALOG.

STEP4 – THE FIT WINDOW(S)

The most important step in the ReEvaluation dialog is to select the parameters for the evaluation of the measured spectra. In the lower part of the page there is a list of reference-files to be used in the evaluation.

To insert a reference into the list press the 'Insert Reference' button.

To remove a reference from the list, select the reference in the list and press the 'Remove Reference' – button.

To see the options for a reference, select the reference in the list and press the 'Properties' button. This will show the dialog seen in Figure 19. It is here possible to change how the given reference file will be used in the fitting.

If you wish to check that the reference files you have specified are ok, then press the button 'View'. This will bring up a dialog as seen in Figure 5 showing the size of the reference files for the range of pixels specified by 'Fit From' and 'Fit To'. If you don't see any red line in the graph, then you should check your reference files.

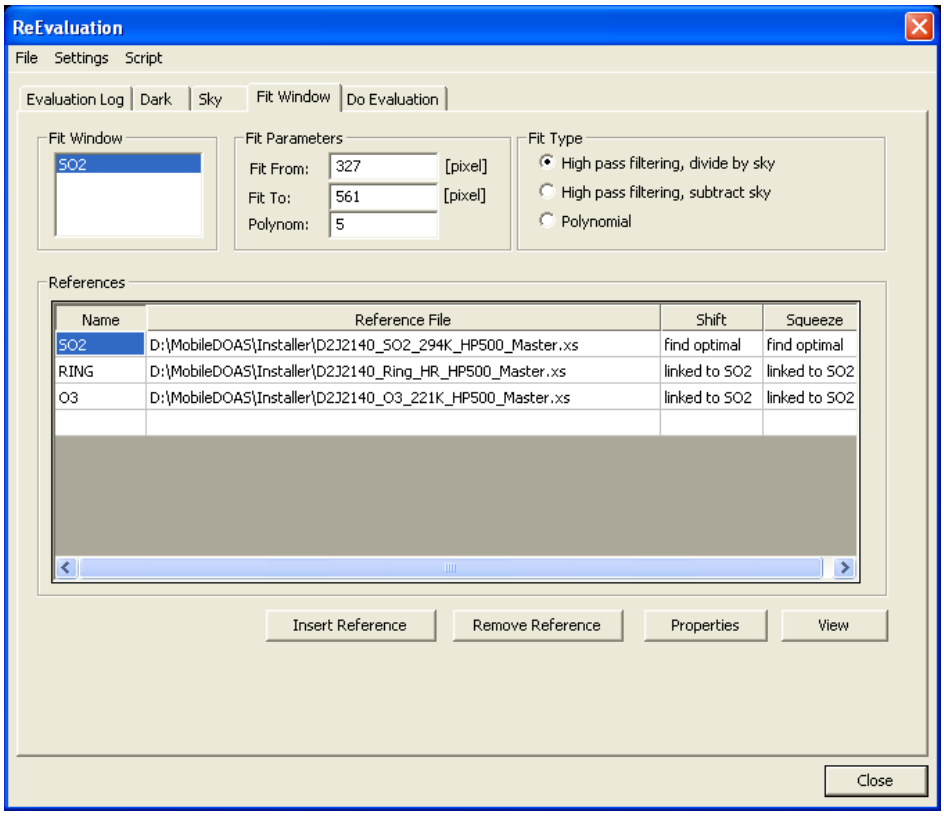

FIGURE 18 - THE FIT-WINDOW PAGE IN THE REEVALUATION DIALOG.

The settings for the fit range and references files are individual for each spectrometer. If you are not sure what settings or reference files to use contact the supplier of your instrument.

STORING FIT WINDOW SETTINGS

When you have configured a set of parameters that works well for your spectrometer then you can save these settings to a file (so that you don't have to type in the same things the next time). To do so select the menu option 'Settings→Save Settings to File' and select where to store the file. The next time you open the re-evaluation dialog these settings can be re-read from the file by selecting the menu option 'Settings→Load Settings from File'. Notice that it is good to make sure that the settings actually work well for your spectrometer before storing them to file. This can be done by running the re-evaluation as described below and when this is done (and all looked fine) select the menu option 'Settings→Save Settings to File'. The stored files will have the file ending .rxml.

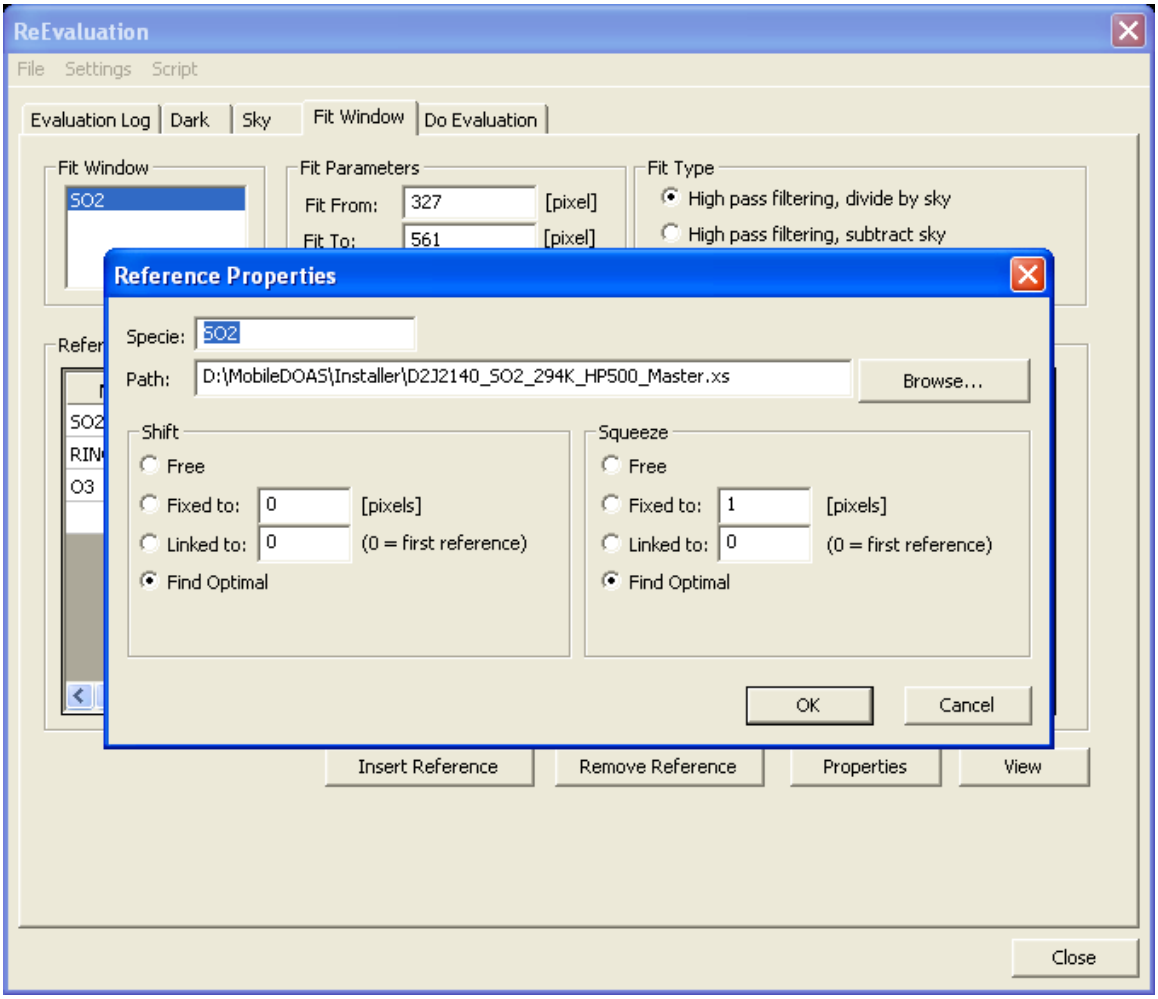

FIGURE 19. THE REFERENCE PROPERTIES DIALOG AS OPENED FROM THE REEVALUATION DIALOG.

STEP5 – RE-EVALUATING

The final page in the ReEvaluation – dialog is the 'Do Evaluation' – page. Pressing the 'Evaluate NOW' button will cause the program to evaluate all the spectra in the measurement using the chosen settings. The spectral fit of each evaluated spectrum will be shown in the graph in the upper right part of the page, and any messages will be shown in the text-box in the upper left part of the page.

Pressing the '**Pause**' – button will cause the re-evaluation to make a pause after the evaluation of each spectrum, to enable visual inspection of the fit. The fit will continue after pressing the 'Next…' button, which replaces the 'Evaluate NOW' button.

Pressing the '**Cancel**' – button to the right of the 'Evaluate NOW' button will cause the program to stop the ReEvaluation.

Note – do not press the 'OK', 'Cancel' or 'Close' buttons in the lower right part of the dialog when spectra are evaluating.

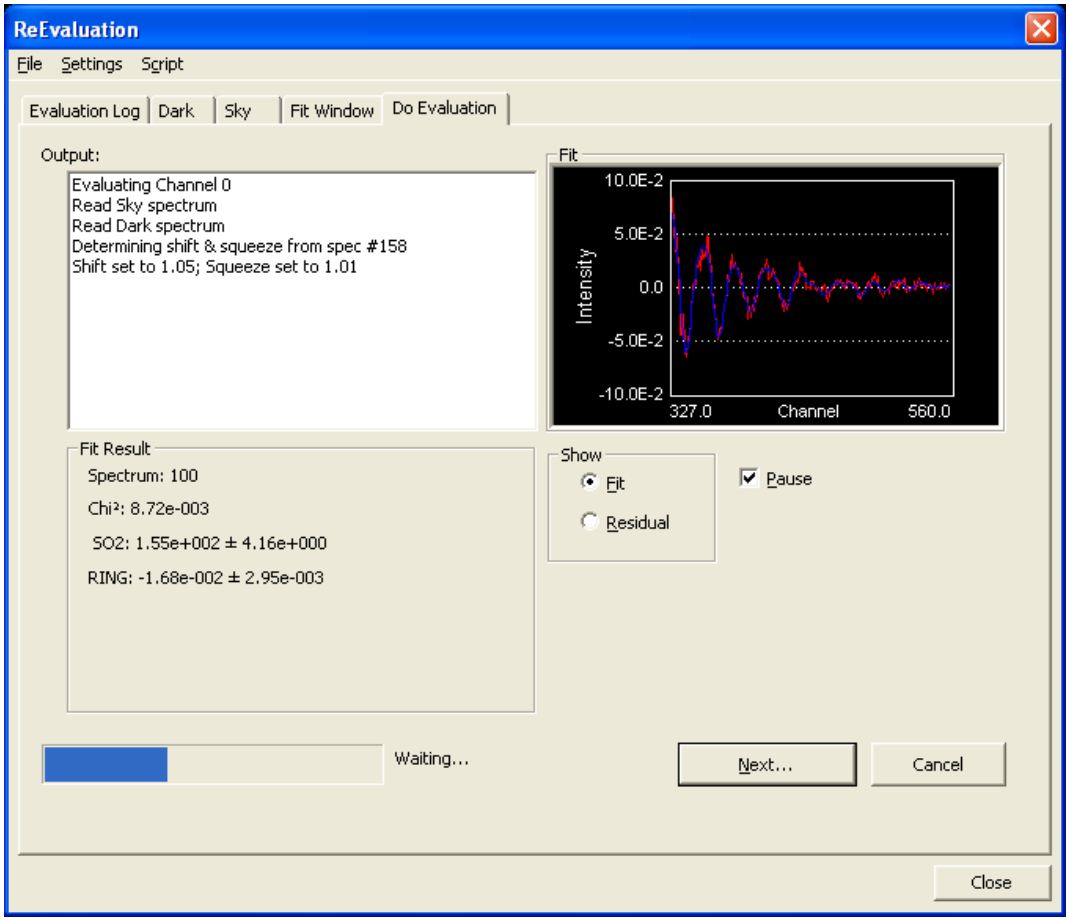

FIGURE 20 - THE FINAL PAGE IN THE REEVALUATION - DIALOG.

EXTRA – SCRIPTING THE RE-EVALUATION (ADVANCED)

If you have a large set of MobileDOAS measurements that you need to ReEvaluate then the possibility to create ReEvaluation scripts can prove useful. You need to prepare this by saving the settings in the fit window page to file (see page 26). The scripts are created through the ReEvaluation Script dialog which is accessed from the ReEvaluation dialog by the menu option 'Script→Create Script', this opens the dialog shown in Figure 21.

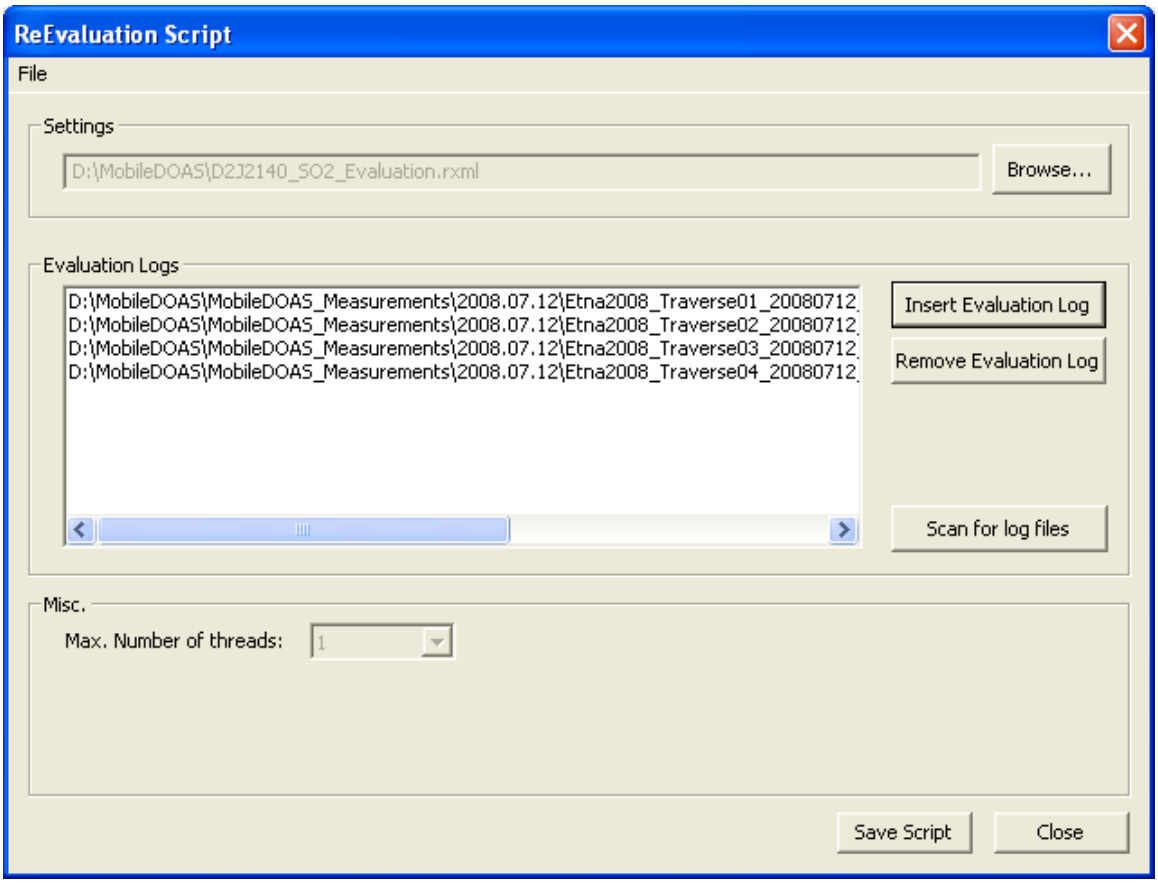

FIGURE 21 – FROM THE REEVALUATION SCRIPT DIALOG IS IT POSSIBLE TO CREATE SCENARIOS FOR BATCH RE-EVALUATION OF MOBILEDOAS MEASUREMENTS.

Begin by selecting the file containing the settings from the fit window page by pressing the button 'Browse' and select the .rxml – file created earlier. You then need to specify the evaluation logs from the measurements you wish to re-evaluate. There are two ways to do this;

1) Press the 'Insert Evaluation Log' button and select an evaluation log file that you wish to process. Press this button again for each evaluation log file you wish to include.
2) Press the 'Scan for log files' button and select a directory. This will scan the directory structure for evaluation log files and automatically insert all evaluation log files in all sub-directories to the one you chose.

You can always remove an evaluation log file from the list by selecting it in the list of files and pressing the button 'Remove Evaluation Log'.

When you are happy with your settings, press the button 'Save Script' in the bottom of the dialog to store the script to file. The file is given the file-ending .rs. You can later open this script again by opening the same dialog and selecting the menu option 'File→Load Script'.

To run a ReEvaluation script, go to the ReEvaluation dialog and select the menu option 'Script→Run Script'. This will automatically start the re-evaluation of the spectra and the results of the spectral fitting will be shown in the graph in the 'Do Evaluation' page. Notice that it can take a very long time for the script to finish.

5. OTHER MEASUREMENT MODES

VIEWING SPECTRA DIRECTLY FROM THE SPECTROMETER

Sometimes it is useful to be able to view spectra directly from the spectrometer without saving the spectra, e.g. when checking the light level, adjusting the optics of the instrument or checking that the fiber is not damaged. There is a special measurement mode in MobileDOAS which does this, to start this click "Control→View Spectrometer Output" in the main menu or click the button  in the toolbar. This will open two new windows, as can be seen in Figure 22.

In this measurement mode are spectra continuously collected using the settings that are found in the "Spectrum collection settings" window. To exit this mode press the stop button in the toolbar or close the program.

The window "Spectrum collection settings" allow you to change the exposure time that is used when acquiring spectra and the number of spectra that are averaged together. If more than one spectrometer is connected to the computer, you can also select which spectrometer should be used. Pressing the button "Save spectrum" allows you to save the last acquired spectrum (the one shown on the screen).

The window "Spectrum scale" modifies the scaling of the plot.

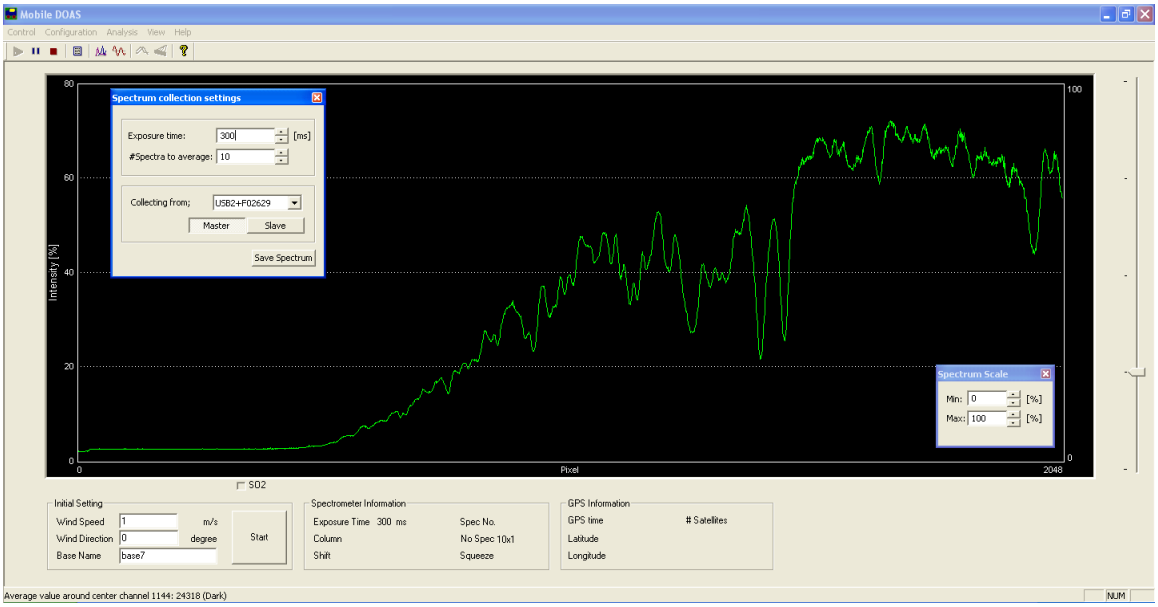

FIGURE 22. IN THE "VIEW" MODE IS IT POSSIBLE TO VIEW THE SPECTRA FROM THE SPECTROMETER IN REALTIME WITHOUT STORING SPECTRA.

6. OTHER FUNCTIONS

VIEWING COLLECTED SPECTRA

It is possible to view the spectra collected in a measurement by opening the Spectrum Inspection Dialog. This can be found by either:

- Clicking on the menu option 'View→Measured Spectra' from the menu in the main window.
- Opening the ReEvaluation dialog, selecting an evaluation log file and pressing the 'View Spectra' button.

In this dialog you can select an evaluation log file by pressing the 'Browse' button. Once the evaluation log file is opened you can see each of the measured spectra and the properties for each single spectrum. The spectra can be browsed through by moving the slider bar just above the spectrum graph. **Notice that the evaluation log file must be in the same directory as the measured spectra.**

It is possible to zoom in the spectrum by clicking and dragging with the left mouse button in the graph. Clicking the right mouse button will restore the zoom level to its original value.

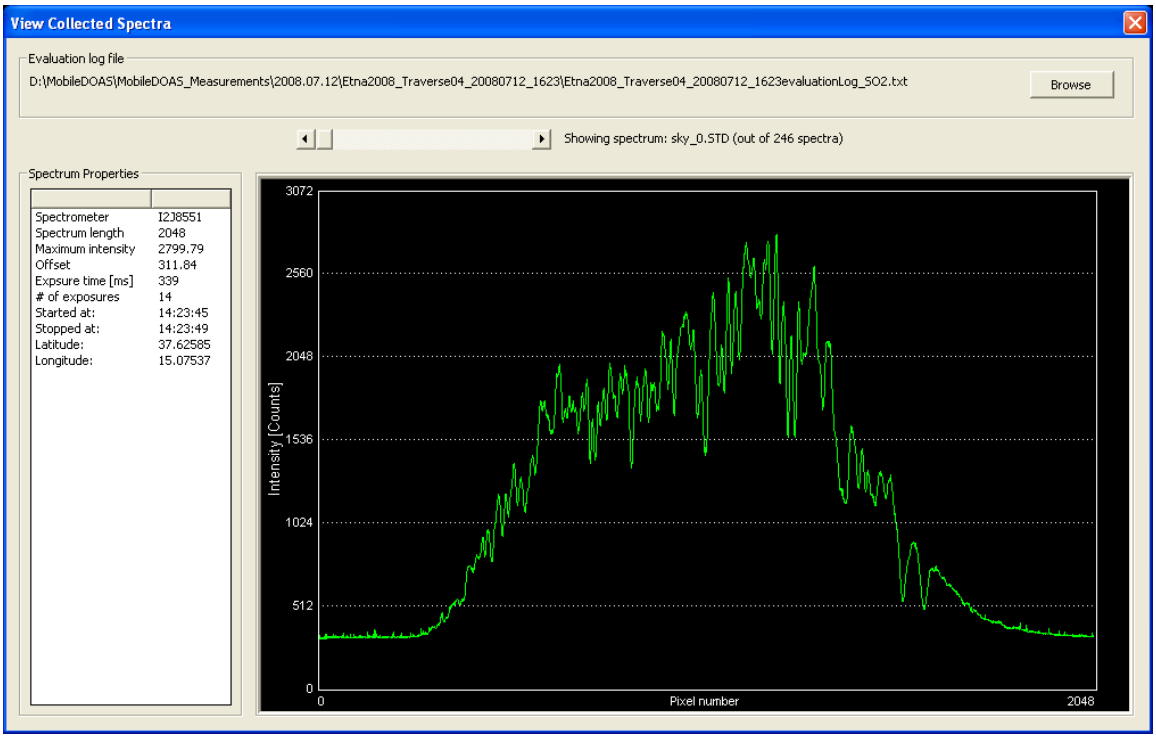

FIGURE 23 – IN THE VIEW COLLECTED SPECTRA DIALOG IS IT POSSIBLE TO LOOK AT EACH OF THE SPECTRA COLLECTED IN A MOBILEDOAS MEASUREMENT.

THE ROUTE DIALOG

You can see a plot of the route traversed during a measurement by first opening the measurement in the Post Flux Calculation dialog then pressing the menu option 'View→Show Route Map' or by right-clicking in the graph and clicking the menu option 'Show Route Map'. The route graph shows the position for each measured spectrum on a square latitude-longitude plot. The start point of the traverse is marked with a big green square, see Figure 24.

The graph can also show the position of the source as a red square if the check button "Show Source" is checked and a latitude and longitude is typed into the "Lat" and "Lon" boxes.

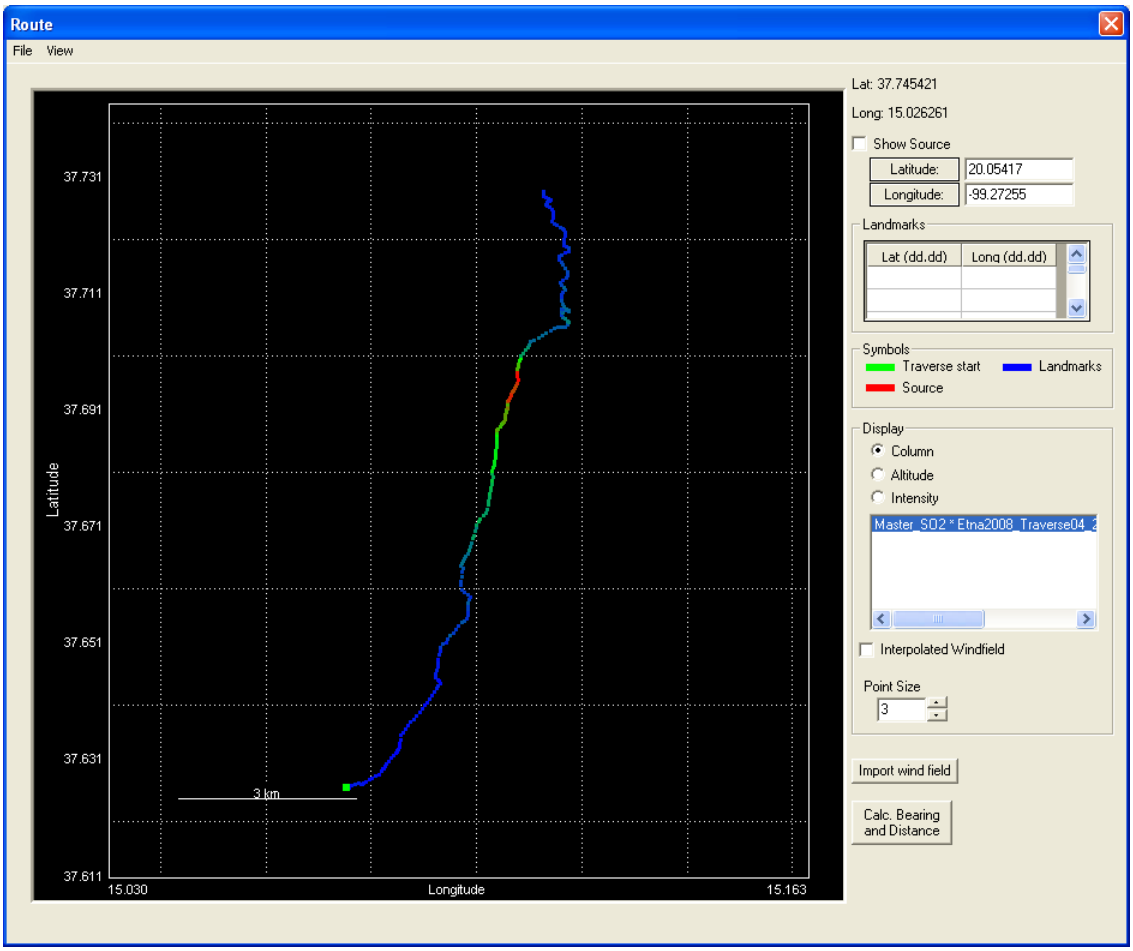

FIGURE 24 – THE ROUTE DIALOG SHOWS A MAP OF THE TRAVERSE. HERE ARE THE COLUMNS SHOWN AS COLORS WITH BLUE AS LOW, GREEN INTERMEDIATE AND RED HIGH COLUMNS.

On the right hand side in the window there is are three radio buttons in the "Display" section. Checking the radio button "Column" will make the graph show the measured column values using a color range varying from blue as the lowest values ranging to red as

the highest values. Using the radio buttons the plot can also be made to show the Column error or the altitude of the measurement, on a relative scale.

In the menu 'View' found in the route dialog there are many options for how to draw the graph, e.g. can the column values in the graph be shown either by color (with blue indicating the lowest values, green as intermediate and red as the highest, see Figure 24) or by size of the squares (larger squares correspond to higher values, see Figure 25).

Also notice that it is possible to zoom the graph by clicking and dragging the mouse cursor in the graph (see Figure 25). The original zoom-level is restored by right clicking anywhere in the graph.

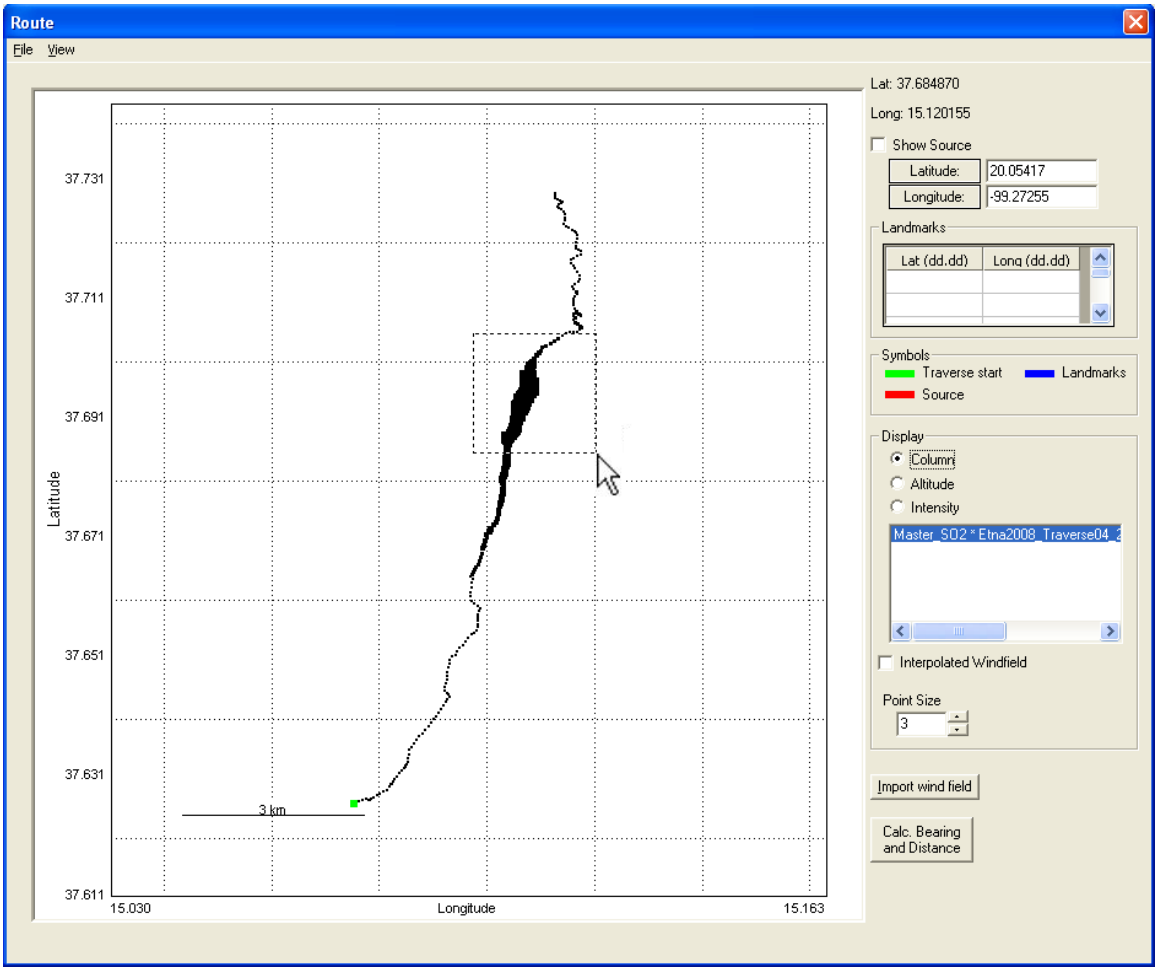

FIGURE 25 – THE ROUTE GRAPH, SET TO THE BLACK AND WHITE COLOR THEME WITH LARGER SQUARES INDICATING LARGER COLUMNS

It is also possible to calculate the distance and bearing between any two points on the graph. Start by pressing the "Calc. Bearing and Distance" button on the right. The program will tell you to click on the first point in the graph. When clicking on the second point in the graph the program will tell you the distance and initial bearing between the two points.

To mark other points on the route graph, then type in their latitude and longitude in the grid under 'Landmarks'. If a wind-field has been imported for the currently shown measurement, the direction of the wind at each measurement-point can be shown by marking the checkbox 'Interpolated Windfield' found in the 'Display' group on the right hand side of the dialog. The colors of the background, the grid and the lines displaying the wind-field can be changed. The entire plot can be saved to a image file in either of the file formats; .bmp, .jpg, .gif or .png.

EXPORTING EVALUATED RESULTS TO GOOGLE EARTH

The gas columns from a measurement with MobileDOAS can be exported to a KML – file (which can be opened by e.g. Google Earth). This is done by opening the evaluation log file in the Post Flux Dialog (see page 16) and selecting the menu option "File→Export traverse to Google Earth" this will bring up a dialog asking for a file name and where to store the file. After pressing "Save" here another dialog will pop up asking for which scaling height to use in the file. The scaling height is the height that the highest column in the measurement will take, what value you should use depends on the terrain around the measurement and the size of the measurement. You can try this process several times with different scaling heights and try which one looks good for you.

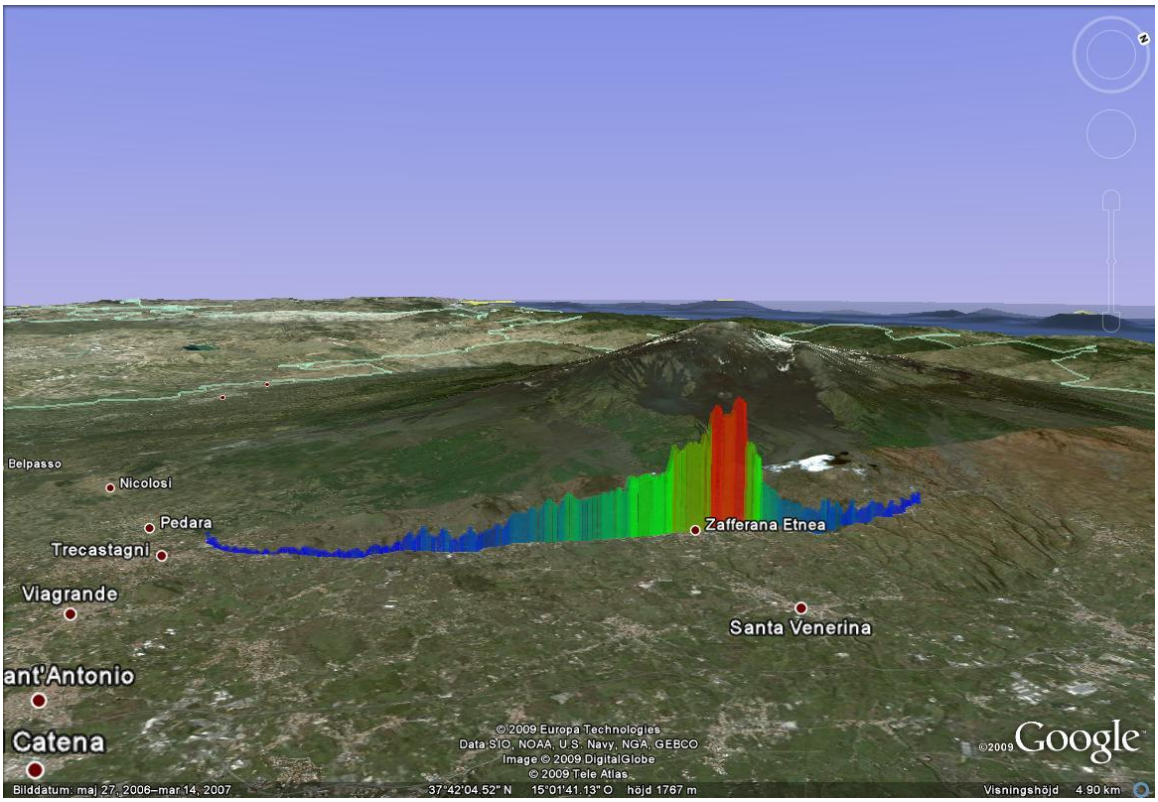

FIGURE 26 – A MEASUREMENT MADE WITH MOBILEDOAS EXPORTED TO KML AND SHOWN IN GOOGLE EARTH.

TESTING THE GPS-CONNECTION

When using a GPS-receiver with USB-port that simulates a serial-port there can sometimes be an uncertainty of which serial-port contains the GPS-receiver. This can be tested by pressing 'Control→Test The GPS' in the menu in the main-window. This will sequentially run through the serial-ports 1 to 10 and test each one for the presence of a GPS-receiver. When a GPS-receiver is found, the user will be informed of the name and number of the serial-port through a message-box.

PLOT SETTING

You can set the background color and the plot color. Choose "Plot Setting->Set Background Color" to change background color. Choose "Plot Setting->Set Plot Color" to change the histogram color.

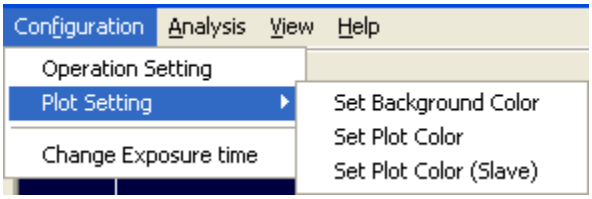

FIGURE 27 - MENU – PLOT SETTING

FIGURE 28 - COLOR DIALOG

PAUSE AND EXIT

Click on the toolbar to pause the program.

Click on the toolbar to exit the program.

7. FILE FORMATS

OLD CONFIGURATION FILE (VERSION < 4.4)

cfg.txt was the configuration file of the program up to version 4.4.

PARAMETERS

TABLE 7-1 - CONFIGURATION PARAMETERS

Parameter	Description	Scope	Example
SPEC_BAUD	Baud rate of the spectrometer	2400, 4800, 9600, 19200, 38400, 57600, 115200	57600
SERIALPORT	Port for the spectrometer	USB or COM1, COM2, COM3, …	COM1
GPSBAUD	Baud rate of the GPS	Depends on the GPS receiver.	4800
GPSPORT	Port for the GPS receiver	COM1, COM2, …	COM3
SKIPGPS	Use GPS receiver or not	0 – use GPS receiver; 1 – do not use GPS receiver.	0
FIXEXPTIME	Exposure time	0 – automatic exposure time, 5~65535 – program uses this specific exposure time	0
TIMERESOLUTION	Time between storing two consecutive spectra. In milliseconds.	>2500	3000
SPECCENTER	The pixel around which to measure the intensity of the spectrum.	1~ 2047	1150
PERCENT	The desired intensity of the spectrum around the pixel specified by SPECCENTER.	0~1	0.8
REFFILE	Name of reference spectrum file (including path)	The length of file path should be less than 100 characters. Use "\" to separate folders.	D:\spec\ref.txt
FIXSHIFT	Fix shift	0 or 1	1

FIXSQUEEZE	Fix squeeze	0 or 1	1
FITFROM	Start wavelength	0~2047	327
FITTO	Stop wavelength	0~2047	560
POLYNOM	The order of the polynomial to include in the DOAS fit.	0 – 5	5
MAXCOLUMN	The max column to decide the beep volume	Beep volume = (current column/max column)*max volume.	200
GASFACTOR	The conversion factor to convert from ppmm to mg/m^2	>0. Depends on the specific gas.	2.66 – for SO_2

EXAMPLE OF CONFIGURATION FILE

```
SPEC_BAUD=57600
SERIALPORT=COM1
GPSBAUD=9600
GPSPORT=COM5
SKIPGPS=0
TIMERESOLUTION=6000
FIXEXPTIME=0
FIXSHIFT=1
FIXSQUEEZE=1
FITFROM=327
FITTO=460
POLYNOM=9
SPECCENTER=199
PERCENT=0.8
MAXCOLUMN=200.0
REFFILE=D:\code\ref.txt
GASFACTOR=2.66
```

NEW CONFIGURATION FILE (VERSION 4.4 OR HIGHER)

cfg.xml is the configuration file of the program as from version 4.4. The new file format allows for much more flexibility in the configuration than did the old. All versions of MobileDOAS are capable of reading the old file format (*cfg.txt*) however as from version 4.4 MobileDOAS can only write the new file format (*cfg.xml*).

PARAMETERS

The configuration file consists of a number of parameter definitions and a number of sections. These are all described below, an example of a cfg.xml file can be seen on page 41.

Parameter	Description	Scope	Example
serialPort	The port to use, normally USB but can also be any COM – port	USB, COM1, COM2, …	USB
timeResolution	Time between two consecutive spectra measurements (In milliseconds. Used for the exposure time calculation).	>500	5000
nchannels	Number of channels to use in the spectrometer	1 ~ 2	1
maxColumn	Beep volume = (current column/max column)*max volume.		200

THE OFFSET SECTION

The offset section defines how MobileDOAS should correct for the offset of the spectra. This feature enables a first level compensation for stray-light in the spectrometer but can also compensate for a changing offset level (for spectrometers which have a problem with this).

If both from and to are set to 0 then no offset correction will be performed.

Parameter	Description	Scope	Example
from	The lowest pixel to use when calculating offset	1 ~ 2048	50
to	The highest pixel to use when calculating offset	1 ~ 2048	200

THE INTENSITY SECTION

The parameters described in the intensity section are used to determine the exposure time for the spectra. The parameters used are:

Parameter	Description	Scope	Example
Channel	The pixel around which to measure the intensity of the spectrum.	1~ 2047	1150
Percent	The desired intensity of the spectrum around the pixel specified by Channel. In percent.	0~100	80
FixExpTime	How to calculate the exposure time. 0 corresponds to automatic exposure time. A value larger than 0 corresponds to a fixed exposure time (in milliseconds) A value smaller than 0 corresponds to adaptive exposure time.		

THE GPS SECTION

The GPS section defines how (and if) MobileDOAS should communicate with the GPS receiver.

Parameter	Description	Scope	Example
use	Use GPS receiver or not	1 – use GPS receiver; 0 – do not use GPS receiver.	1
Baudrate	The baud rate to use when communicating with the GPS	1200 - 115200	4800
port	The serial port to use when communicating with the GPS	COM1, COM2,…	COM4

THE FITWINDOW SECTION

The fit window section defines how to evaluate the spectra that are collected in the measurement. There can be several fit windows defined, they must however differ either in the channel they use or in the name.

The fit window section also contains a number of Reference-sections, each defining how to fit a single reference file to the spectrum.

Parameter	Description	Scope	Example
name	The name of the fit window.	Any string	SO2
fitLow	The first pixel to use when performing the DOAS fit.	1 ~ 2048	340
fitHigh	The highest pixel to use when performing the DOAS fit.	1 ~ 2048	561
spec_channel	The channel on the spectrometer that this fit window is valid for.	0 – 1	0
Polynomial	The order of the polynomial to include in the DOAS fit.	0 – 5	5

The parameters for the Reference section

Parameter	Description	Scope	Example
name	The name of the reference	Any string	SO2
path	The full path to the reference file (including directory and file name)	Any string	C:\spec\SO2_reference.xs
gasFactor	The conversion factor to convert from ppmm to mg/m^2	>0. Depends on the specific gas.	2.66 – for SO_2
shift	The shift to apply to the reference when performing the DOAS fit		fix to 0.0
squeeze	The squeeze to apply to the reference when performing the DOAS fit		fix to 1.0

EXAMPLE OF CONFIGURATION FILE

```
<?xml version="1.0" encoding="ISO-8859-1"?>
<!-- This is the configuration file MobileDOAS -->
<Configuration>
	<serialPort>USB</serialPort>
	<timeResolution>5000</timeResolution>
	<nchannels>1</nchannels>
	<maxColumn>200.00</maxColumn>
	<Intensity>
		<Percent>80</Percent>
		<Channel>1144</Channel>
		<FixExpTime>0</FixExpTime>
	</Intensity>
	<GPS>
		<use>1</use>
		<baudrate>4800</baudrate>
		<port>COM4</port>
	</GPS>
	<Offset>
		<from>50</from>
		<to>200</to>
	</Offset>
	<FitWindow>
		<name>SO2</name>
		<fitLow>327</fitLow>
		<fitHigh>460</fitHigh>
		<spec_channel>0</spec_channel>
		<polynomial>5</polynomial>
		<Reference>
			<name>SO2</name>
			<path>References\...
				D2J2140_SO2_294K_HP500_Master.xs</path>
			<gasFactor>2.66</gasFactor>
			<shift>fix to 0.00</shift>
			<squeeze>fix to 1.00</squeeze>
		</Reference>
		<Reference>
			<name>O3</name>
			<path>References\...
				D2J2140_O3_221K_HP500_Master.xs</path>
			<gasFactor>1.93</gasFactor>
			<shift>fix to 0.00</shift>
			<squeeze>fix to 1.00</squeeze>
		</Reference>
		<Reference>
			<name>Ring</name>
			<path>References\...
				D2J2140_Ring_HR_HP500_Master.xs</path>
			<gasFactor>0.0</gasFactor>
			<shift>fix to 0.00</shift>
			<squeeze>fix to 1.00</squeeze>
		</Reference>
	</FitWindow>
</Configuration>
```

REFERENCE FILE

The reference files should contain the differential cross section of 1 ppmm of a single specie of interest e.g. SO_2 or NO_2.

The reference files that are used should be in ASCII format and contain only one or two columns. If the file contains only one column, then this should specify the magnitude of the reference cross section. If the file contains two columns then the left should specify the wavelength.

The file can end with .txt or .xs.

SPECTRUM FILE

The program records all the spectra in the extended STD file format, which is a human readable ASCII – file format.

The sky spectrum is stored as sky.STD file.

The dark spectrum is stored in dark.STD file.

All other spectra are stored in STD files named with continuous numbers.

If using multi-channel spectrometers, the spectra from the master channel will end with "_0.STD" and the spectra from the slave channel will end with "_1.STD".

EVALUATION LOG FILE

The program generates the evaluation file in which evaluation results are stored.

The beginning of the file is the copy of configuration. After that comes a table containing the GPS time, latitude, longitude, altitude (from the GPS), number of spectra averaged in each saved spectrum, exposure time of the spectrum (in ms), average intensity, column, column error and the name and path to the spectrum file.

EXAMPLE OF EVALUATION LOG FILE

```
***Desktop Mobile Program***
VERSION=5.0
FILETYPE=evaluationlog
BASENAME=test07
WINDSPEED=8.000000
WINDDIRECTION=0.000000
***copy of related configuration file ***
SERIALPORT=USB
GPSBAUD=4800
GPSPORT=COM4
TIMERESOLUTION=5000
FIXEXPTIME=0
FITFROM=327
FITTO=460
POLYNOM=5
FIXSHIFT=1
FIXSQUEEZE=1
SPECCENTER=1144
PERCENT=0.800000
MAXCOLUMN=200.000000
GASFACTOR=2.660000
REFFILE=C:\MobileDOAS\References\D2J2140_SO2_294K_HP500_Master.xs
REFFILE=C:\MobileDOAS\References\D2J2140_O3_221K_HP500_Master.xs
REFFILE=C:\MobileDOAS\References\D2J2140_Ring_HR_HP500_Master.xs

***Spectrometer Information***
SERIAL=USB2+F02629
DETECTORSIZE=2048
DYNAMICRANGE=65536
MODEL=USB2000+

#Time   Lat   Long   Alt   NSpec   ExpTime   Intens(Master)   Master_Column_SO2
       Master_ColumnError_SO2       Master_Column_O3       Master_ColumnError_O3
       Master_Column_Ring Master_ColumnError_Ring STD-File(Master)

04:43:56     40.021327    116.391560    33.0   57     168    2503   6.298089
       2.275804     3.26184      1.23825      0.45783      0.64279
              C:\Beijing2005\RingRoad5_M02_20050811_1243\00000_0.STD
04:44:06     40.021323    116.391548    34.0   57     168    2519   4.409573
       1.726646     3.58373      1.32817      0.38236      0.72816
       C:\Beijing2005 \RingRoad5_M02_20050811_1243\00001_0.STD
04:44:16     40.021332    116.391560    32.0   57     168    2526   7.606338
       1.573019     3.928361     1.8263828    0.827352     0.517282
       C:\Beijing2005\RingRoad5_M02_20050811_1243\00002_0.STD
```

FLUX CALCULATION FILE

Flux calculation file is generated after the post flux calculation. It locates in the same place with the evaluation log file that has been calculated.

Example

Processed file: G:\ TB07200409221421\TB07200409221421evaluationLog.txt

Processed time: 2004.10.11 17:16:43

Wind Speed=10.000000

Wind Direction=0.000000

Source latitude=0.000000

Source longitude=0.000000

Column offset=-20.918013

0.006492 kg/s

FILE FORMAT TO IMPORT MODELED WIND-FIELD

The MobileDOAS can import the results from meteorological models into the post-flux calculation in order to improve the quality of the calculated flux. The wind field is in plain ASCII for simplicity. The ordering is primarily on position, with one paragraph for each position. Each paragraph starts with the line:

```
Lat=XX.XXXX Long=YY.YYYYYY
```

The latitude is positive on the northern hemisphere and the longitude is positive in the eastern hemisphere.

The following line is a header-line for the data-table for that position. The header-line should have the following format:

```
Altitude    Hour   WD [deg]    WS [m/s]    Hour   WD [deg]    WS [m/s]
```

Where the three strings '`Hour  WD [deg]  WS [m/s]`' is repeated once for each time-stamp available for that altitude. Notice that each item is separated by tabs, except for the separation between the item ('WD' or 'WS') and their unit which are separated by spaces.

The data-table is sorted with one altitude per line and three columns for each time-stamp. An example of a line in the data-table matching the above given header-line:

```
98.07 21    140.58    10.85 22    147.84    11.36
```

The unit of the altitude is optional, this is only to give the data meaning to the user and is not used in the flux calculation. The unit of the wind speed must be meters per second and the wind direction must be in degrees.

Each paragraph is followed by one or more empty lines, marking the end of the paragraph. There cannot be more than 24 time-values for each altitude (each accompanied with one wind direction and one wind speed) and no more than 50 altitudes for each measurement point. As conclusion, an example of a small wind-field data file;

Lat=19.491840 Long=-99.015170

Altitude	Hour	WD [deg]	WS [m/s]	Hour	WD [deg]	WS [m/s]
28.55	21	136.77	9.35	22	144.89	9.74
98.07	21	140.58	10.85	22	147.84	11.36
192.71	21	143.82	11.06	22	150.58	11.62
313.09	21	147.63	10.86	22	153.99	11.41

Lat=19.493700 Long=-99.015380

Altitude	Hour	WD [deg]	WS [m/s]	Hour	WD [deg]	WS [m/s]
28.55	20	140.08	6.74	21	136.77	9.35
98.07	20	143.00	7.73	21	140.58	10.85
192.71	20	145.26	7.84	21	143.82	11.06
313.09	20	147.86	7.66	21	147.63	10.86

Lat=19.512640 Long=-99.014650

Altitude	Hour	WD [deg]	WS [m/s]	Hour	WD [deg]	WS [m/s]
28.54	21	140.11	8.86	22	147.05	9.92
98.03	21	142.39	10.34	22	149.01	11.57
192.61	21	144.40	10.57	22	151.06	11.82
312.93	21	146.89	10.40	22	153.81	11.60

8. TROUBLE SHOOTING

All suggestions presented in this chapter aim to allow the users to solve the most common problems they may encounter.

The following error messages can occur:

Communication problem, restart data collection	
Description	The communication between the spectrometer and the computer does not work or the spectrometer has no power.
Solution	Check whether the serial cable is well connected. Check whether the spectrometer has power.
Timeout	
Description	The communication between the spectrometer and the computer does not work. Or the spectrometer has no power.
Solution	Check whether the serial cable is well connected. Check whether the spectrometer has power.
Spectra are collecting	
Description	You have clicked the "Start" button a second time.
Solution	This does not affect the operation of the program.
First byte of transmission is incorrect	
Description	The communication between the spectrometer and the computer does not work correctly. This only happens when communicating with the spectrometer through a serial cable.
Solution	Check the physical connection and restart the program.
Cannot handle more than X channels. Changed number of channels to 2	
Description	You have specified too many channels in the configuration file. MobileDOAS can only handle two channels simultaneously.
Solution	This will change your settings to use only two channels. Next time change the settings before starting the program.

A negative amount of channels defined in the configuration file. This does not make sense, will change number of channels to 1

or

Zero channels defined in the configuration file. This does not make sense, will change number of channels to 1

Description	You have specified an illegal number of channel in the configuration file.
Solution	Revise the settings and restart.

There are no reference-files defined in the configuration file. Please check settings and restart

Description	You have not specified any references in the cfg.xml file or there are errors in cfg.xml.
Solution	Check the settings and restart.

Cannot open reference file : XYZ for reading

or

Can not read reference file XYZ Please check the file location and restart collection

Description	One of the reference files specified in cfg.xml is in the wrong format, not readable or not existing.
Solution	Check the settings and restart.

There are X columns in the reference file. This programs wants reference files with one or two columns

Description	One of the reference files specified in cfg.xml is in the wrong format.
Solution	Check the reference files specified in cfg.xml and restart.

Length of the reference file is: X values. Cannot handle references with more than Y data-points.

Description	One of the reference files specified in cfg.xml is too long.
Solution	Check the reference files specified in cfg.xml and restart.

Could not open evaluation log file. No data was written! **Or** **Could not write log file: XYZ. Not enough free space?**	
Description	The evaluation log file could not be opened for writing. Maybe the disk is full or you don't have write access to the directory where MobileDOAS resides.
Solution	Check the disk and your rights. Can you create a file manually?
Could not create output directory.	
Description	The output directory could not be created. Maybe the disk is full or you don't have write access to the directory where MobileDOAS resides.
Solution	Check the disk and your rights. Can you create a directory manually?
No spectrometer found. Make sure that the spectrometer is attached properly to the USB-port and re-start the program.	
Description	The program could not contact the spectrometer.
Solution	Check that the spectrometer is plugged in. If it is then it might help to unplug it, wait a little and plug it in again.
Cfg.txt specifies 2 channels to be used but spectrometer can only handle one. Changing configuration to handle only one channel	
Description	The configuration specifies that two channels are to be used but the spectrometer only has one.
Solution	Check cfg.xml and restart.
fit exception	
Description	The evaluation procedure is not correct.
Solution	Check that the reference file is correct, that the fit range is valid and that you have not specified the same reference file twice in a fit window.

Failed to initialize spectrometer **Or** **NAK1** **or** **TimeoutX**	
Description	This can happen when using the serial port to communicate with the spectrometer. Either a failure in the serial cable or in the power supply to the spectrometer.
Solution	Check the physical connection to the spectrometer, check that the spectrometer has power and restart the program.
Could not communicate with GPS. No GPS-data can be retrieved!	
Description	The communication with the GPS failed for some reason.
Solution	Stop the program. Check the physical connection to the GPS receiver, check that the correct baud rate and serial port has been entered in the settings.
Illegal GPS-Port. No GPS-data can be retrieved!	
Description	The serial port for the GPS receiver that is specified in the configuration does not exist on this computer.
Solution	Check the settings and restart.
It seems like the dark spectrum is not completely dark, consider restarting the program	
Description	MobileDOAS tries to judge if the collected dark spectrum actually is dark.
Solution	Look at the dark-current spectrum that is drawn on the screen (typically in green). If this is not a dark spectrum then restart the program and try again. If this is a dark spectrum then you can continue the measurement.

It seems like the sky spectrum is dark, consider restarting the program	
Description	MobileDOAS tries to judge if the collected sky spectrum has enough intensity to be useful.
Solution	Look at the spectrum that is drawn on the screen (typically in green). If this indeed has too little light then restart the program and try again. If this is an ok spectrum then you can continue the measurement.
Length of the reference file is: X values. Cannot handle references with more than Y data-points.	
Description	One of the reference files specified in cfg.xml is too long.
Solution	Check the reference files specified in cfg.xml and restart.
Length of the reference file is: X values. Cannot handle references with more than Y data-points.	
Description	One of the reference files specified in cfg.xml is too long.
Solution	Check the reference files specified in cfg.xml and restart.
Length of the reference file is: X values. Cannot handle references with more than Y data-points.	
Description	One of the reference files specified in cfg.xml is too long.
Solution	Check the reference files specified in cfg.xml and restart.
Length of the reference file is: X values. Cannot handle references with more than Y data-points.	
Description	One of the reference files specified in cfg.xml is too long.
Solution	Check the reference files specified in cfg.xml and restart.