A Graphical User Interface

for RTTOV v11.3

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Change record			
Version	Date	Author / changed by	Remarks
1	2014-05-21	P.Roquet	Initial version
1.1	2014-06-06	J.Hocking	Minor updates for release.
2	2015-09-18	P.Roquet	Updates for RTTOV11.3

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1. Introduction

This document explains how to install and run the graphical user interface of RTTOV. This interface allows the user to modify an atmospheric profile, run RTTOV for a given instrument to produce the radiances and brightness temperatures, and visualize the results instantly.

1.1. Installation

Using RTTOV GUI requires the following software to be installed :

- python2.7 (http://www.python.org/download/)

- wx python version 2.9.5 (http://www.wxpython.org)

- numpy (http://scipy.org/Download)

- matplotlib with backend_wxagg (http://matplotlib.org/)

- h5py version 2.0 or later (http://www.h5py.org/)

- HDF5 v1.8.8 or later (http://www.hdfgroup.org/HDF5/)

- RTTOV v11.3

The GUI also requires the f2py package to interface the Fortran and Python code. This is distributed as part of Numpy v1.6 and later.

An easy way to install python 2.7 and all the python required packages is to use the anaconda distribution of python proposed by continuum analytics http://continuum.io/downloads.

Anaconda already includes numpy, matplotlib and h5py and by default is installed on your home directory. :

Add *$HOME/anaconda/bin* to your *PATH* :

```
$ export PATH=$HOME/anaconda/bin:$PATH
```

You can add this line to your *~/.profile* (or *~/.bash_profile* or similar).

Then, you just have to install the wxpython package with the conda command (which is part of anaconda) :

```
$ conda install wxpython
```

The RTTOV GUI is provided as part of the RTTOV package in the gui/ directory.

Edit the file build/Makefile.local to point to your HDF5 installations (see section 5 of the RTTOV user guide for more information about this).

Compile RTTOV with the rttov_compile.sh script : Change to the src/ directory and type:

```
$ ../build/rttov_compile.sh
```

If your python installation is correct the script must see that f2py is present : answer "y" at the question "...f2py detected: do you want to compile the Python wrapper and RTTOV GUI? (y/n)".

Be sure that the HDF5 library used for RTTOV is consistent with that used by h5py.

The rttov_gui_f2py.so symbolic link must point to the rttov_gui_f2py.so which is built in the RTTOV lib/ directory.

RTTOV GUI needs profile files : hdf5 or ASCII files. ASCII files are actually python source code files (see section 4).

ASCII and HDF5 versions of the RTTOV test suite profiles are included in the rttov_test/profile-datasets-py and rttov_test/profile-datasets-hdf directories.

Update the rttov_gui.env environment file according to your installation (see next section).

Run the GUI :

```
$ source ./rttov_gui.env
$ ./rttovgui
```

If you use the emissivity and/or BRDF atlases with the GUI then note that you must use the HDF5 versions of the BRDF and IR emissivity atlas files.

2. RTTOV GUI User Manual

2.1. Configuration files

The rttov_gui.env contains mandatory environment variables which are used by RTTOV GUI.

This file must be customized to your specific installation. In most cases this only requires the RTTOV_GUI_PREFIX variable to be specified with the absolute path to your RTTOV gui/ directory.

Example of rttov_gui.env file :

```
# RTTOV GUI Environment
#
# Mandatory variables :
# -------------------

# RTTOV GUI installation directory

# absolute path to the rttov/gui directory e.g. /home/user/rttov11/gui
RTTOV_GUI_PREFIX=
export RTTOV_GUI_PREFIX

PATH=${RTTOV_GUI_PREFIX}:$PATH
export PATH

PYTHONPATH=${RTTOV_GUI_PREFIX}:${PYTHONPATH}
export PYTHONPATH
```

```
# Optional environment variables : (the defaults are usually OK)
# -----------------------------

# Directory for rttov emissivity and BRDF atlases: this should be the directory
# containing the emis_data/ and brdf_data/ directories which hold the atlas
# datasets. NB The HDF5 BRDF and IR emissivity atlas files must be used.

RTTOV_GUI_EMISS_DIR=${RTTOV_GUI_PREFIX}/../
export RTTOV_GUI_EMISS_DIR


# Working directory (for rttov gui temporary files)

RTTOV_GUI_WRK_DIR=$HOME/.rttov
export RTTOV_GUI_WRK_DIR


# Default directory for rttov coefficients files

RTTOV_GUI_COEFF_DIR=${RTTOV_GUI_PREFIX}/../rtcoef_rttov11
export RTTOV_GUI_COEFF_DIR


# Default directory for profile files

RTTOV_GUI_PROFILE_DIR=${RTTOV_GUI_PREFIX}/../rttov_test/profile-datasets-hdf
export RTTOV_GUI_PROFILE_DIR
```

2.2. Files created by the RTTOV GUI

The RTTOV GUI software will create various files in its working directory defined by the RTTOV_GUI_WRK_DIR environment variable (~/.rttov by default.).

Most of these files are encoded in the HDF5 format. It is possible to look at them using the hdfview software for instance. Exporting data to text file is also possible using the h5dump command.

These files are :

- profile.h5 : contains the profile and options.

- surface.h5 : contains information about the surface and emissivity / reflectance used as input and computed by RTTOV or modified by user.

- radr.h5 : contains radiances computed by a run of RTTOV.

- trns.h5 : contains transmittances computed by a run of RTTOV.

- kmat.h5 : contains the K matrix computed by a run of RTTOV K

- pc.h5 : contains the pcscores computed by a run of PC-RTTOV.

- pckmat.h5 :contains the K PC matrix computed by a run of PC-RTTOV K

- tmpFileErr.log : last RTTOV error log file.

- tmpFileOut.log : last RTTOV output log file

- rttovgui.log : RTTOVGUI log file.

2.3. Starting the GUI

```
$ source ./rttov_gui.env
$ ./rttovgui
```

The RTTOV GUI main window is launched (see Figure 2.3.1) : it allows you to load coefficient files (through the RTTOV menu), to open a profile (through the File menu), to modify options, profile and surface parameters if necessary (through the dedicated windows available through the Windows menu) and to run the RTTOV direct model (through the RTTOV menu). The application log is displayed in this main window.
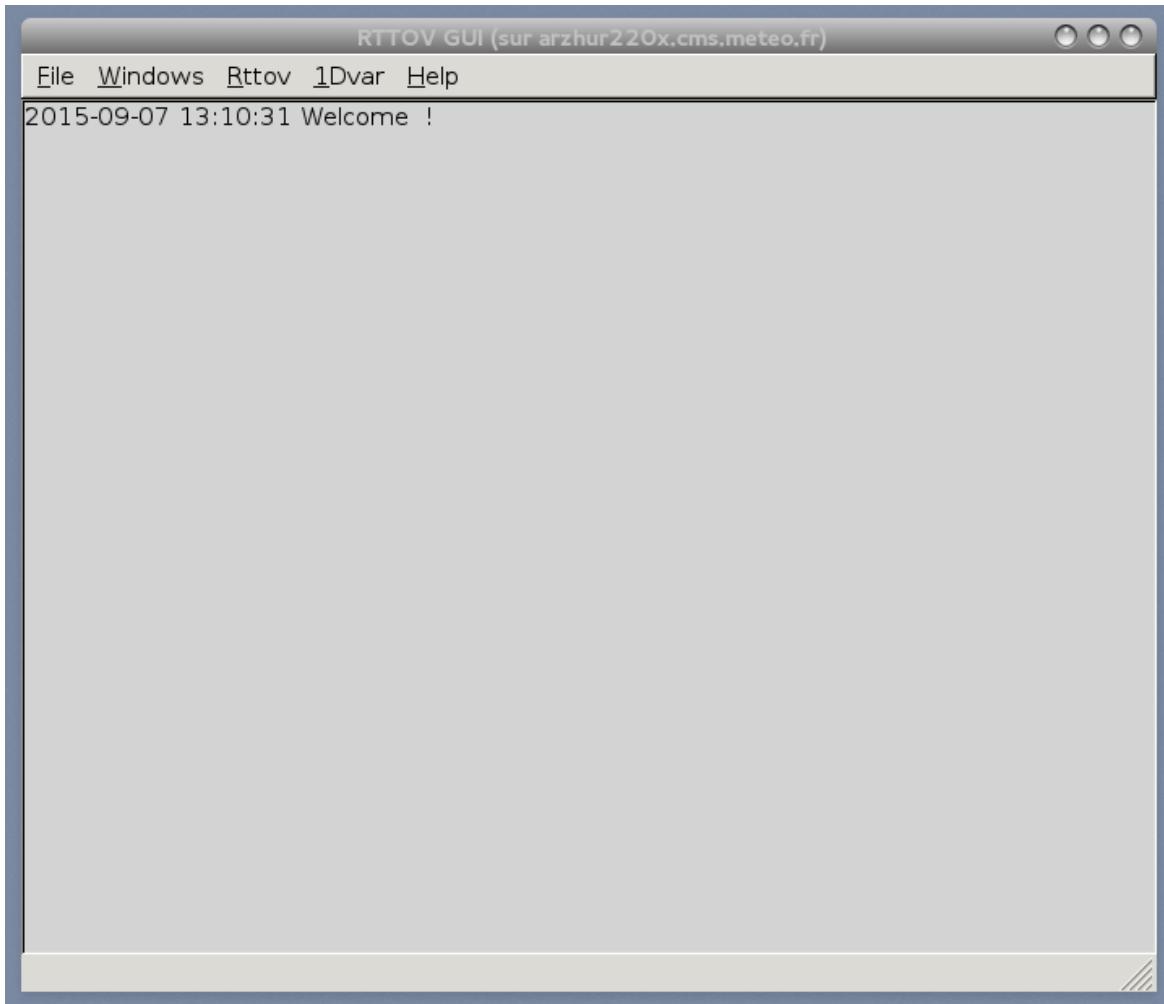
Figure 2.3.1 : main window

2.4. Loading RTTOV coefficient files

The first step is to choose an instrument you want to work with. For this purpose, you have to pick a coefficient file using the RTTOV menu "Load coefficient" (figure 2.4.1).

You must choose a file by clicking on the Choose button.

An RTTOV coefficient file is always mandatory. If you want to work with aerosols you must choose an aerosols coefficient file, and if you want to work with clouds, you must choose a cloud coefficient file. All these files must be compatible (i.e. they must be for the same instrument and contain coefficients for the same channel set).

Once your choices have been made, you can load the coefficient files by clicking on the "Load" button, or by clicking on the "File" menu and selecting the "Load coefficient" menu item.
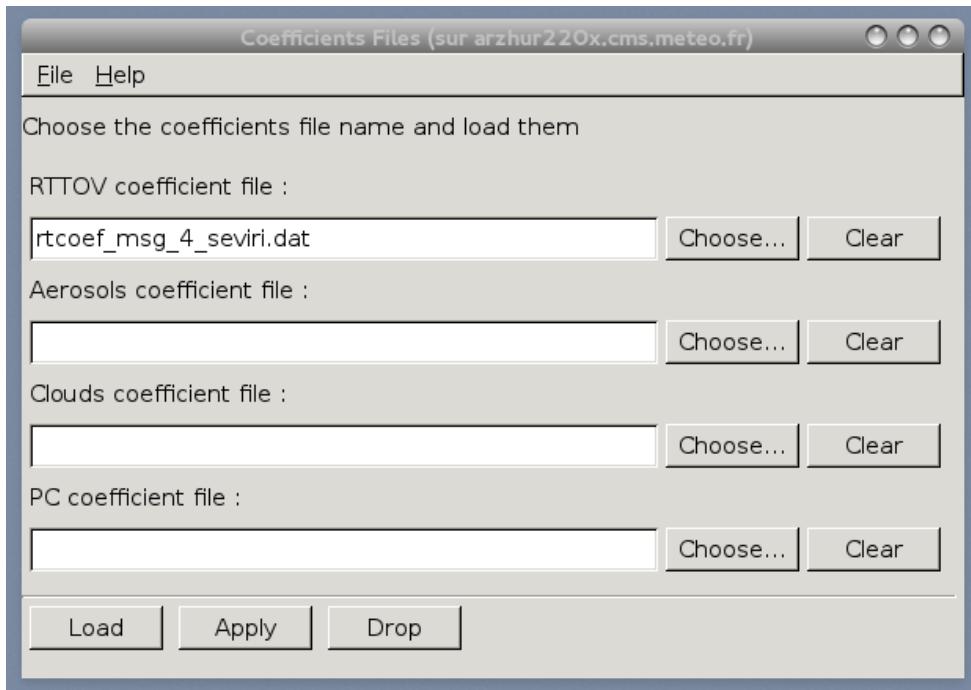
Figure 2.4.1 : choose a coefficient file

When the coefficient files are successfully loaded by RTTOV an information window appears (figure 2.4.2). The log in the main window provides some information from the coefficient files such as the wave numbers and the reference temperatures of the instrument.
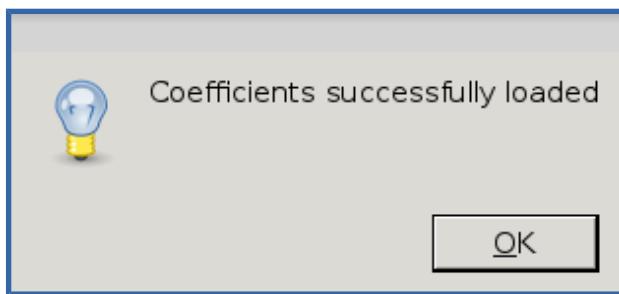
Figure 2.4.2 : information window

2.5. Open a Profile

The item "Open Profile" of the "File" menu of the main window permits you to open a profile stored in HDF5 format (figure 2.5.1). If a profile file contains several profiles, you will be asked to choose the profile number (figure 2.5.2). A selection of HDF5 profiles from the RTTOV test suite can be found in rttov_tests/profile-datasets-hdf/.

The "File" menu item "Open ASCII Profile" allows you to read profiles stored in Python-formatted ASCII files. Section 4 below contains more information about the HDF5 and ASCII profile file formats.
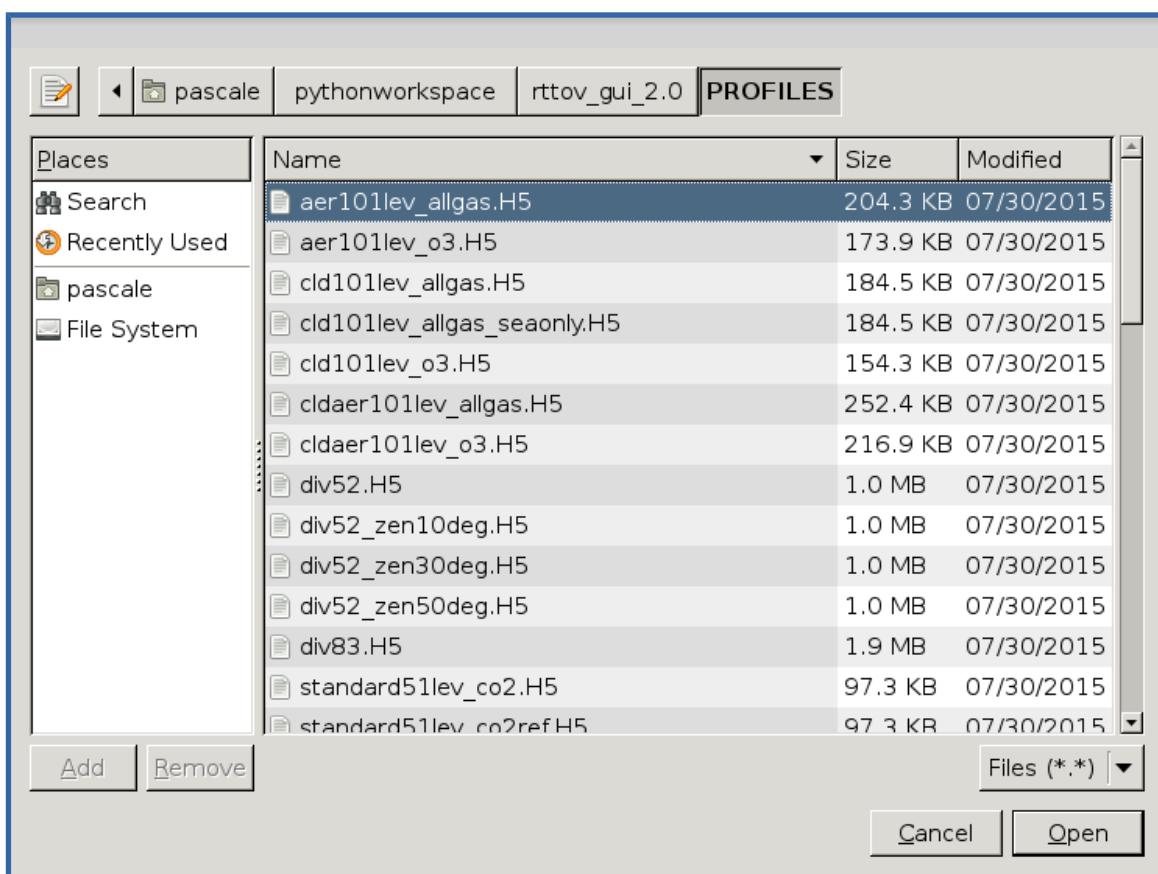
Figure 2.5.1 : select a profile
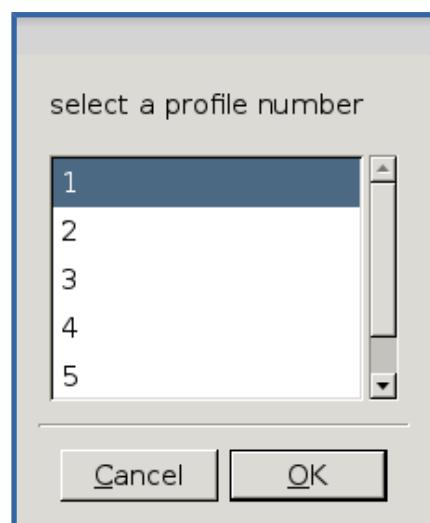
Figure 2.5.2 : choose a profile number

2.6. Modifying the options

The RTTOV options can be modified through the Options editor window. Select "Options Editor Window" from the "Windows" menu of the main window (fig 2.6.1).

The RTTOV options which can be modified are part of the option structure of RTTOV, described in the RTTOV v11 User Guide (Annex O). The help menu of the Options editor windows gives you some information. Some options are unavailable depending to the loaded coefficient files or the profile content. For example, the "addclouds" option can only be checked if you have loaded a cloud coefficient file. The "addaerosl" option can also only be checked if an aerosols coefficient file is loaded. PC-RTTOV options can be modified only if you have loaded a PC RTTOV coefficient file. Once you have made your choices you have to save them for the run by clicking the "Apply" button.
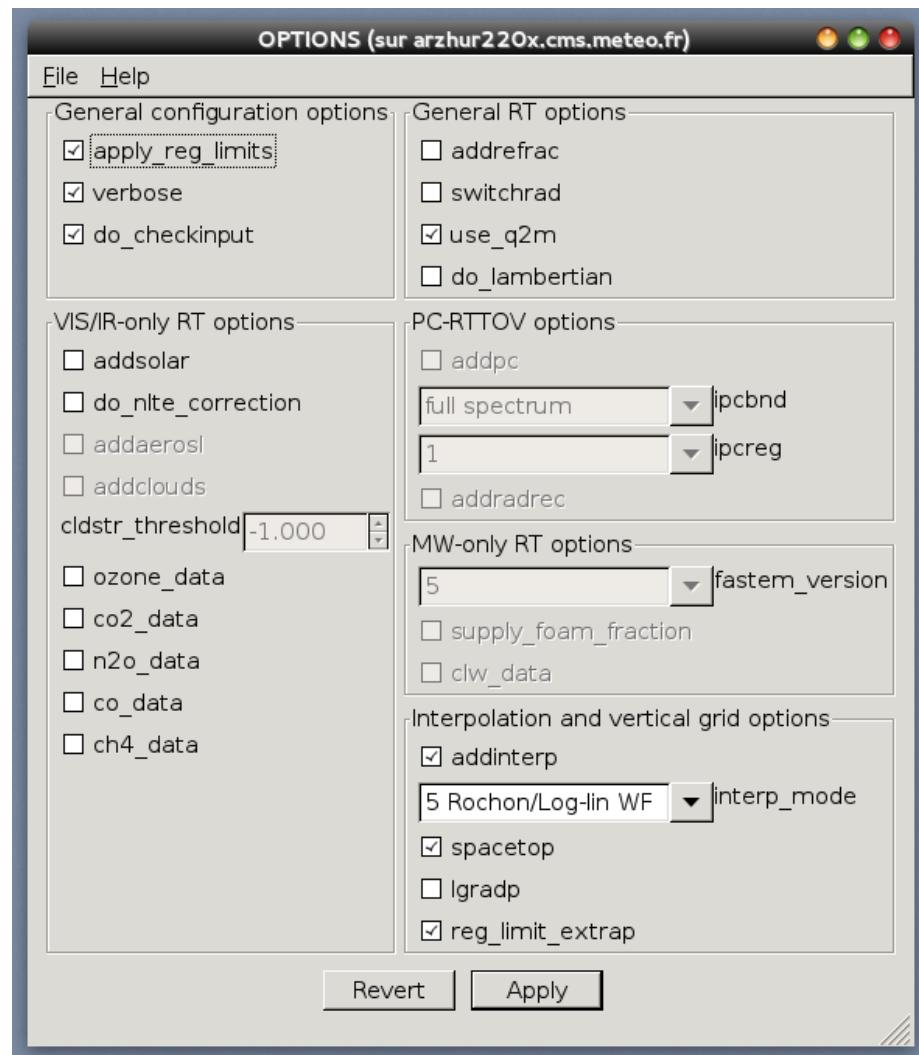
Figure 2.6.1 : Option Editor window

2.7. Modifying the profile

The profile can be modified through the profile editor window. Select "Profile Editor Window" from the "Windows" menu of the main windows.

Figure 2.7.1 displays an example of the profile editor window showing the atmospheric gas profiles.

Figures 2.7.2 and 2.7.3 display examples for aerosol and cloud profiles respectively. Aerosol components and cloud types are described in the RTTOV v11 users guide section 8.6 and in section 8.5 respectively.
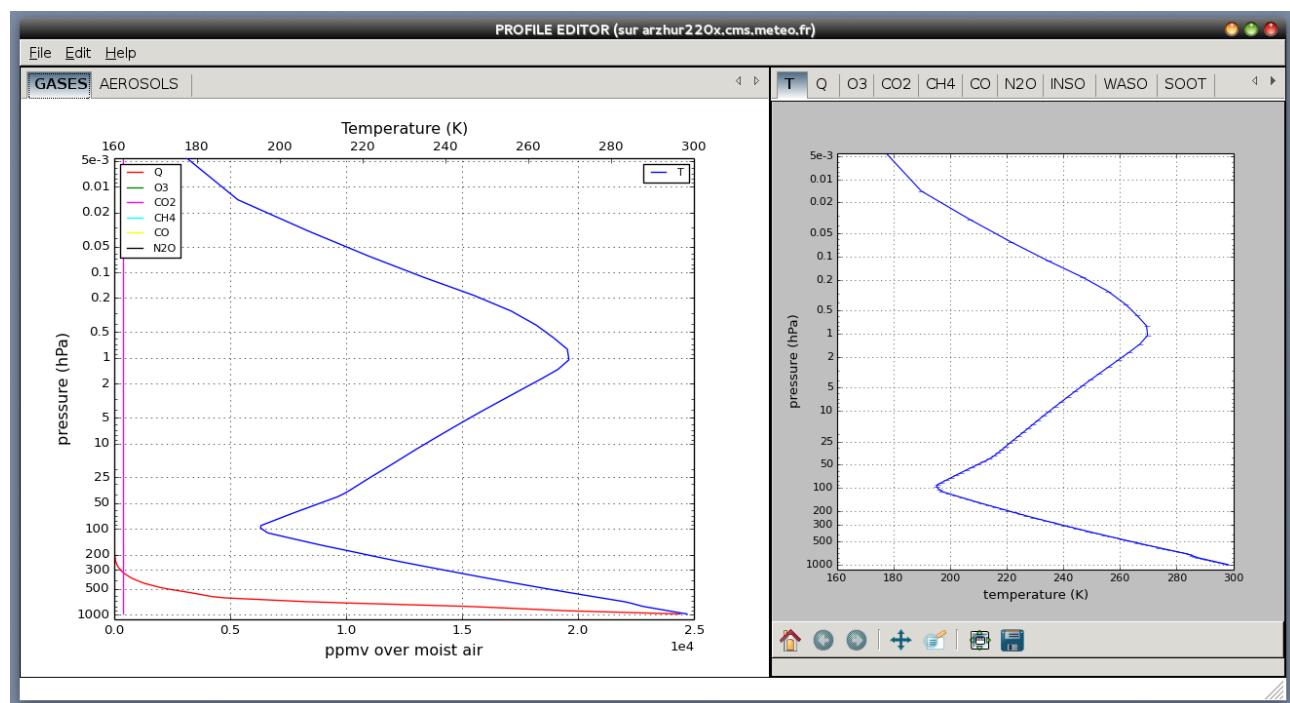
Figure 2.7.1 : Profile Editor window
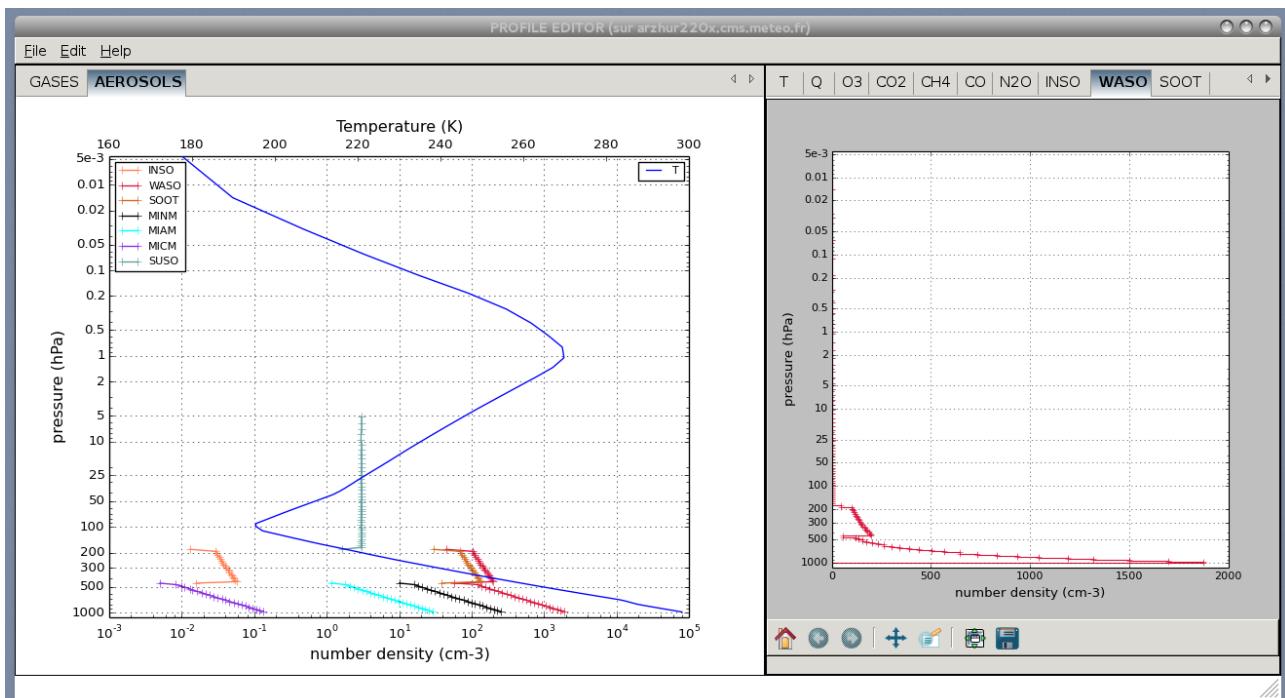
Figure 2.7.2 : Profile Editor window with aerosols
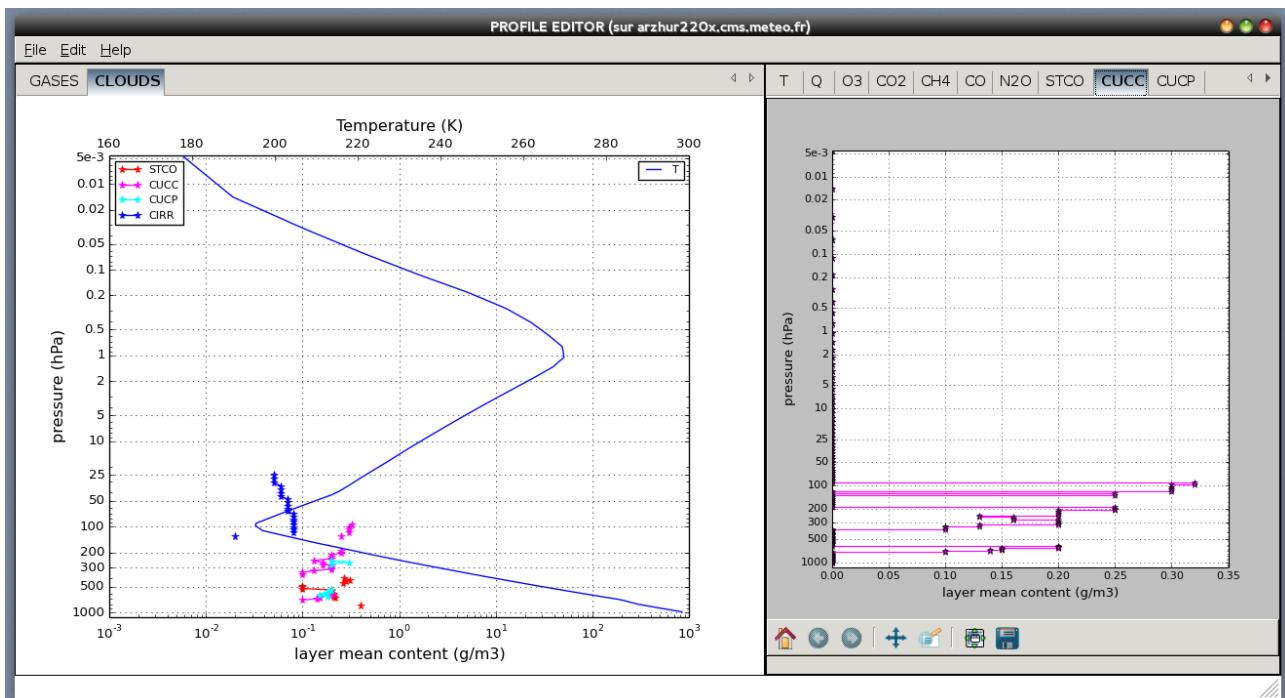
Figure 2.7.3 : Profile Editor window with clouds

The left hand panel of the window shows the atmospheric components profiles grouped by type : Gases, Aerosols and Clouds. The Temperature profile is always drawn on the three types of panel. On the right hand panel of the window, the different components profiles are drawn separately. You can modify the profile by hand by clicking in the panel. For that, select and visualize a component profile on the right panel. Click the middle mouse button to modify the profile. The closest point on a profile pressure level or layer is moved to the new value. The corresponding curve in the left hand panel is also updated. In the right hand panel you can also click with the left mouse button and drag a zone to zoom in. Click the right button to zoom out. Finally, apply your changes or save the profile for the next run of RTTOV using the File menu.

Edit menu options :

Undo : undo the last modification of the curve.

Redo : redo the last modification of the curve.

Insert : For aerosols or clouds only, clicking in the right hand panel moves or creates a new point.

Remove : For aerosols or clouds only, clicking in the right hand panel removes the nearest point (sets the nearest layer concentration to zero).

Edit x axe : Change the X axis bounds.

Add gas : Add a gas.

Remove gas : Remove a gas.

Add aerosol : Add an aerosol particle type.

Remove aerosol : Remove an aerosol particle type.

Add cloud : Add a cloud particle type.

Remove cloud : Remove a cloud particle type.

Replace aerosol by clim : Replace all aerosol profiles with a climatological aerosol selection. The user can choose between different types of climatology (see fig 2.7.4)
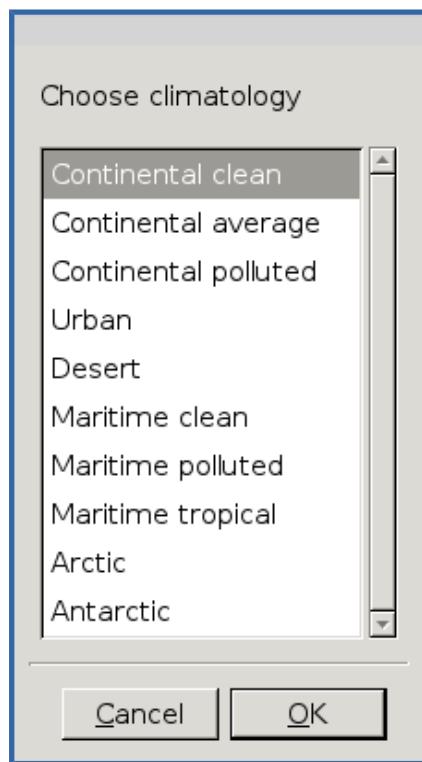
Figure 2.7.4 : Climatology choices for aerosols

2.8. Editing the surface

The Surface Editor Windows allows you to modify the surface parameters of the profile. Select the Surface Editor Window menu item from the windows menu of the main window.(Fig 2.8.1).
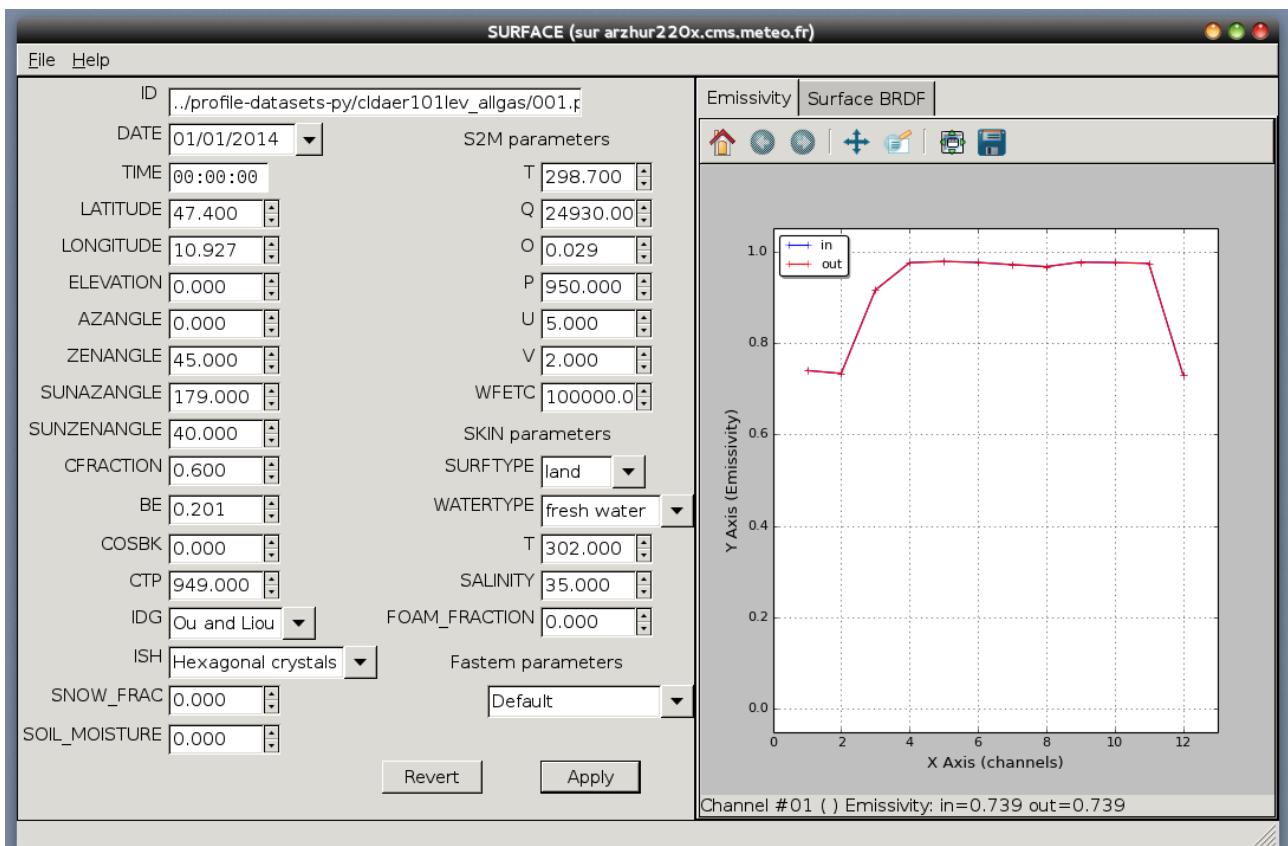
Figure 2.8.1 : Surface Editor Window

The File Menu of the Surface Editor Window allows you to load an atlas, or to modify the value of emissivity or reflectance, channel by channel (Fig 2.8.2). After making changes you must select "Apply changes" from the File menu.

The computed emissivity/reflectance values appear in red on the right hand panel. The input values are in blue. If an atlas is loaded, the RTTOV model does not compute the emissivity or reflectance values.

	EMIS_IN	EMIS_OUT	CALCEMIS
1	0.739449	0.0	☑
2	0.733020	0.0	☐
3	0.915271	0.0	☐
4	0.974937	0.0	☐
5	0.977781	0.0	☐
6	0.975466	0.0	☐
7	0.970726	0.0	☐
8	0.966345	0.0	☐
9	0.976278	0.0	☐
10	0.975189	0.0	☐
11	0.973498	0.0	☐
12	0.731071	0.0	☐

Figure 2.8.2 : Edit Input Emissivity or BRDF Values. (Tip for check boxes : write 1 to check the box and 0 or nothing to un-check the box)

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2.9. *Running RTTOV Direct Model and working with the Radiance Frame*

To run the direct model of RTTOV select "Run direct" from the RTTOV menu in the main GUI window. This will save and overwrite the profile being edited and run the direct model (the profile is saved before each run in the RTTOV GUI working directory: it does not overwrite the original input profile file).

If the run is successful, a new window appears : the radiance window which displays the result of the RTTOV direct model. (Fig 2.9.1)
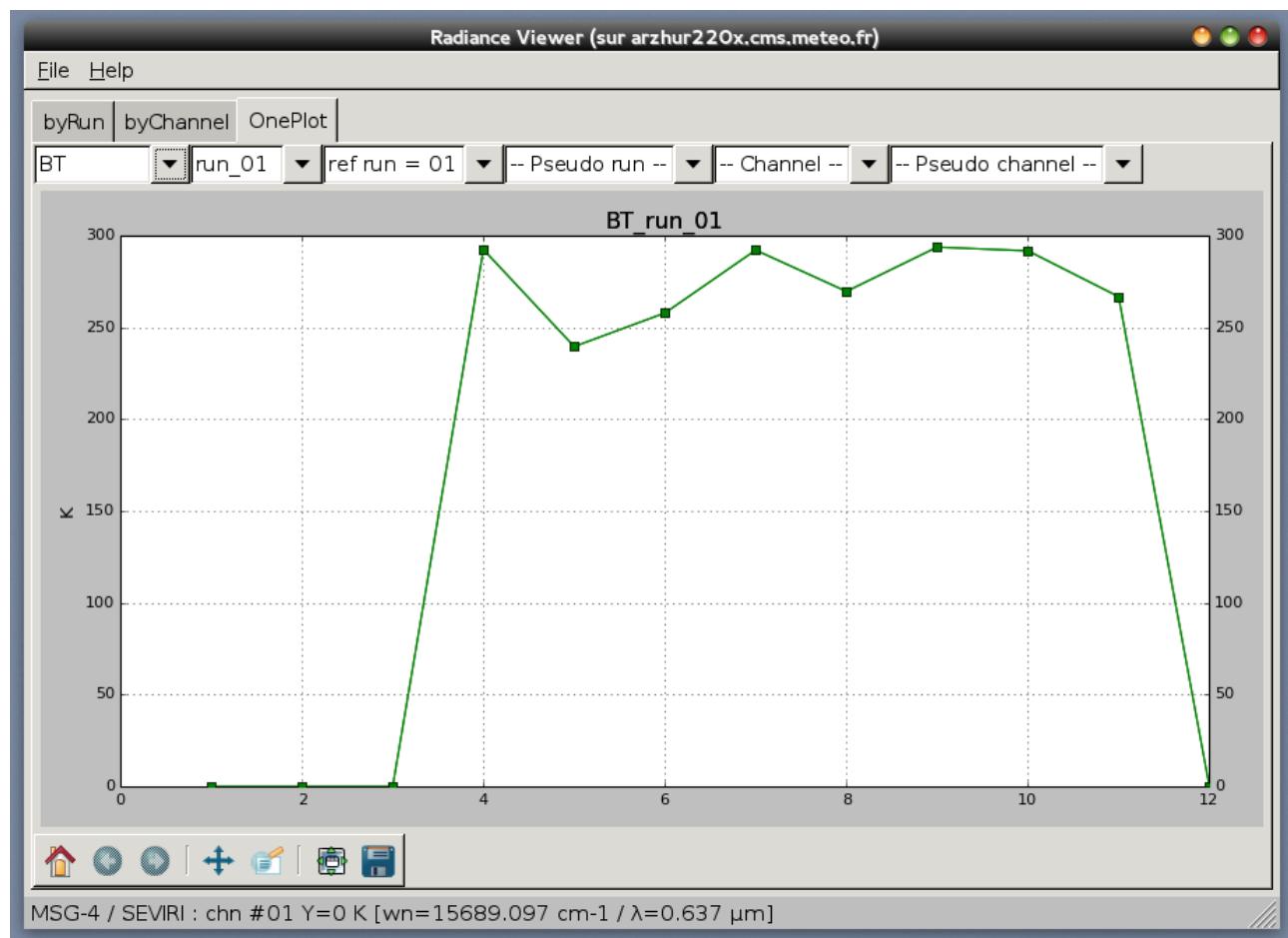
Figure 2.9.1 : Radiance window

The charts displayed in the radiance window are :

- TOTAL : Clear+cloudy top of atmosphere radiance for given cloud top pressure and fraction [mW/cm-1/ster/sq.m]
- CLEAR : Clear sky top of atmosphere radiance (channels) [mW/cm-1/ster/sq.m]
- BT : Brightness temperature equivalent to total radiance [Kelvin]
- BT_CLEAR : Brightness temperature equivalent to clear radiance [Kelvin]
- REFL : Reflectance calculated from total radiance [N/A]
- REFL_CLEAR : Reflectance calculated from clear radiance [N/A]

It is possible to choose different types of visualisation :

byChannel : For each run, view of all charts with all channels values (fig 2.9.1)
In this view you can select :
- **-- Run --** : to choose a run (needs at least 2 different runs)
- **-- Pseudo Run --** : To see the difference between two successive runs (needs at least 2 different runs) (fig 2.9.2)

byRun : For each channel, view of all charts with all runs values
In this view you can select :
- **-- Channel --** : to choose a channel
- **-- Pseudo Channel --** : for channel combinations

OnePlot : View of one chart (fig 2.9.3)
In this view you can select :
- **The parameter** : TOTAL BT REFL +CLEAR : choose a chart type
- **-- Run --** : to choose a run
- **-- Pseudo Run --** : difference between two successive runs
- **-- Channel --** : to choose a channel
- **-- Pseudo Channel --** : for channel combinations
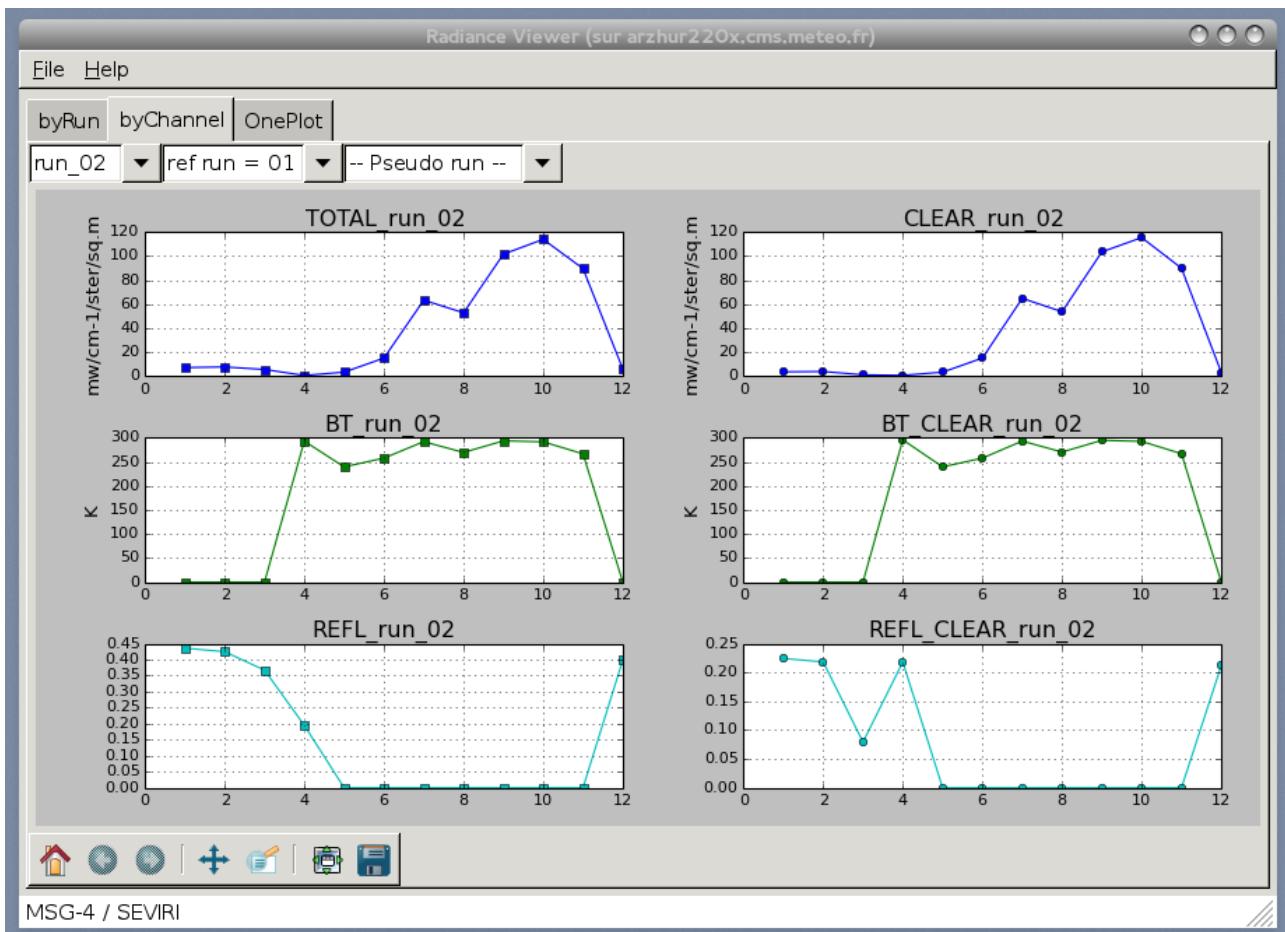
Figure 2.9.2 : Radiance window (by Channel view)

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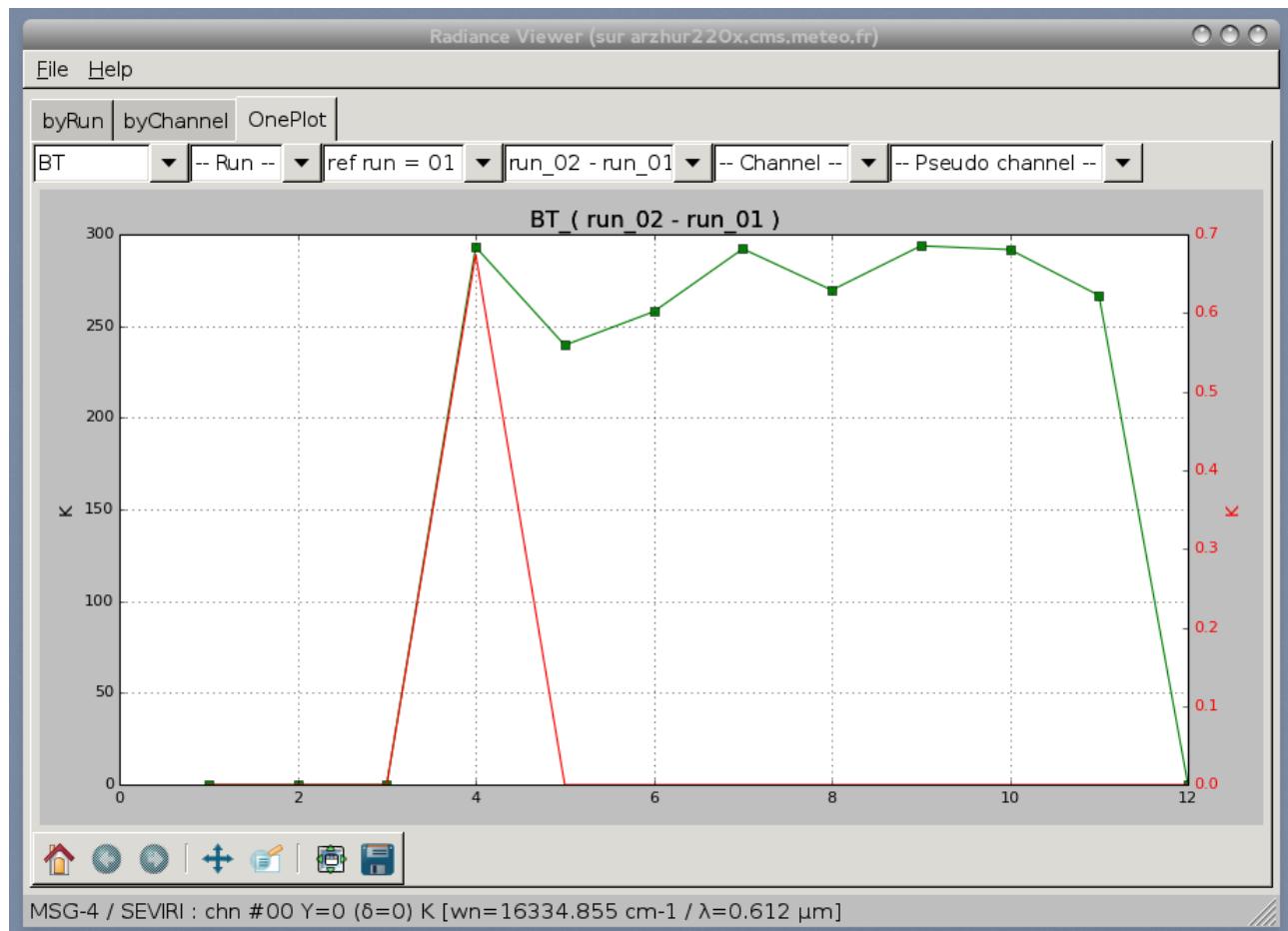
Figure 2.9.3 : Radiance window (One Plot view run2-run1)

In the "byRun" view you may enter your own formula to compute a "pseudo channel", for example you can compute the difference between two channels, or more complicated formula. Your formula will then appear in the "–Pseudo Channel –" list. (fig 2.9.4)
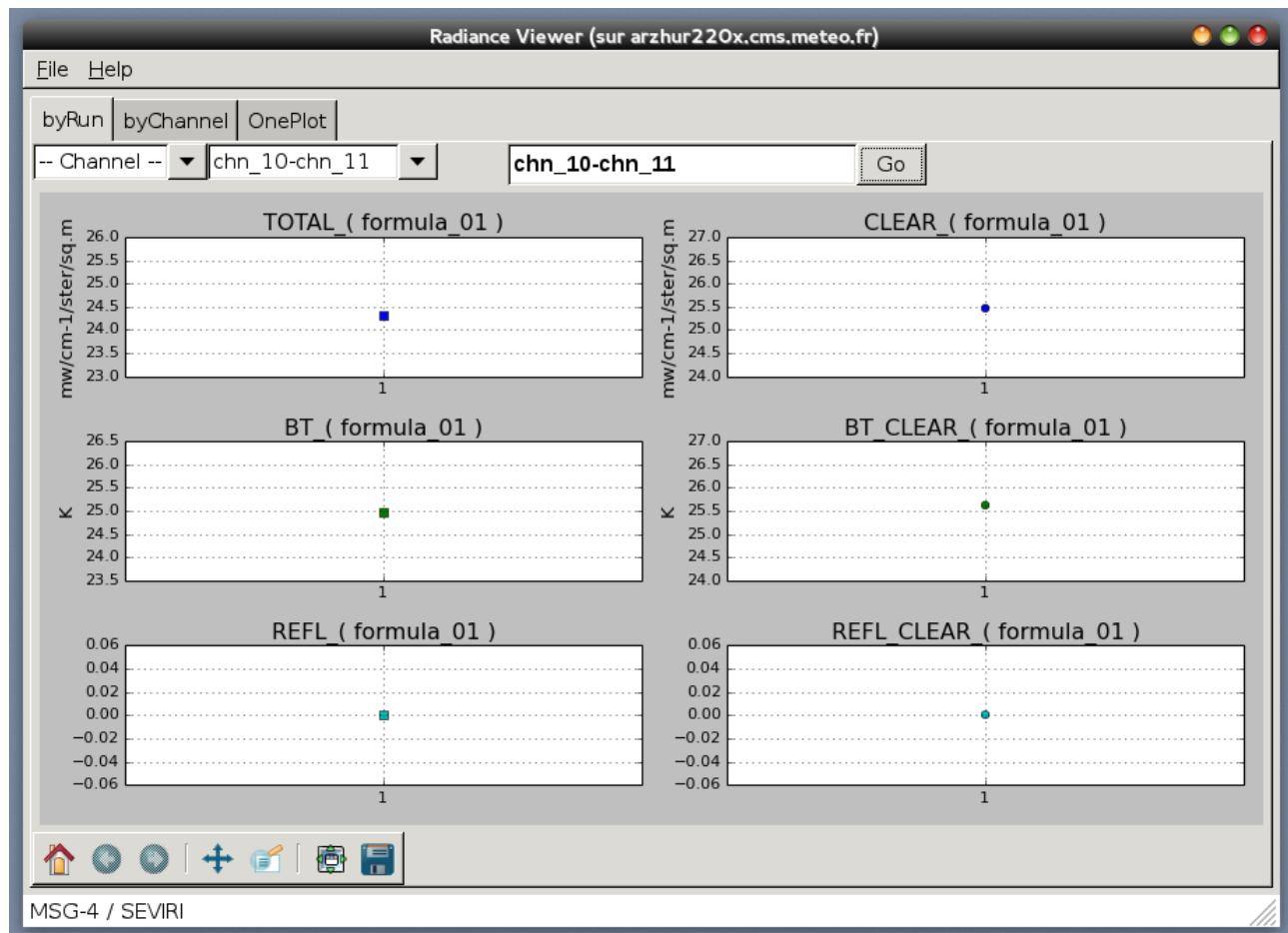
Figure 2.9.4 : Radiance window (Compute a pseudo channel)

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For high-resolution sounders such as IASI, AIRS or CrIS, a spectrum is displayed when the direct model is run (fig. 2.9.5). For these instruments, the X axis is labelled in wavenumber (cm^{-1}).
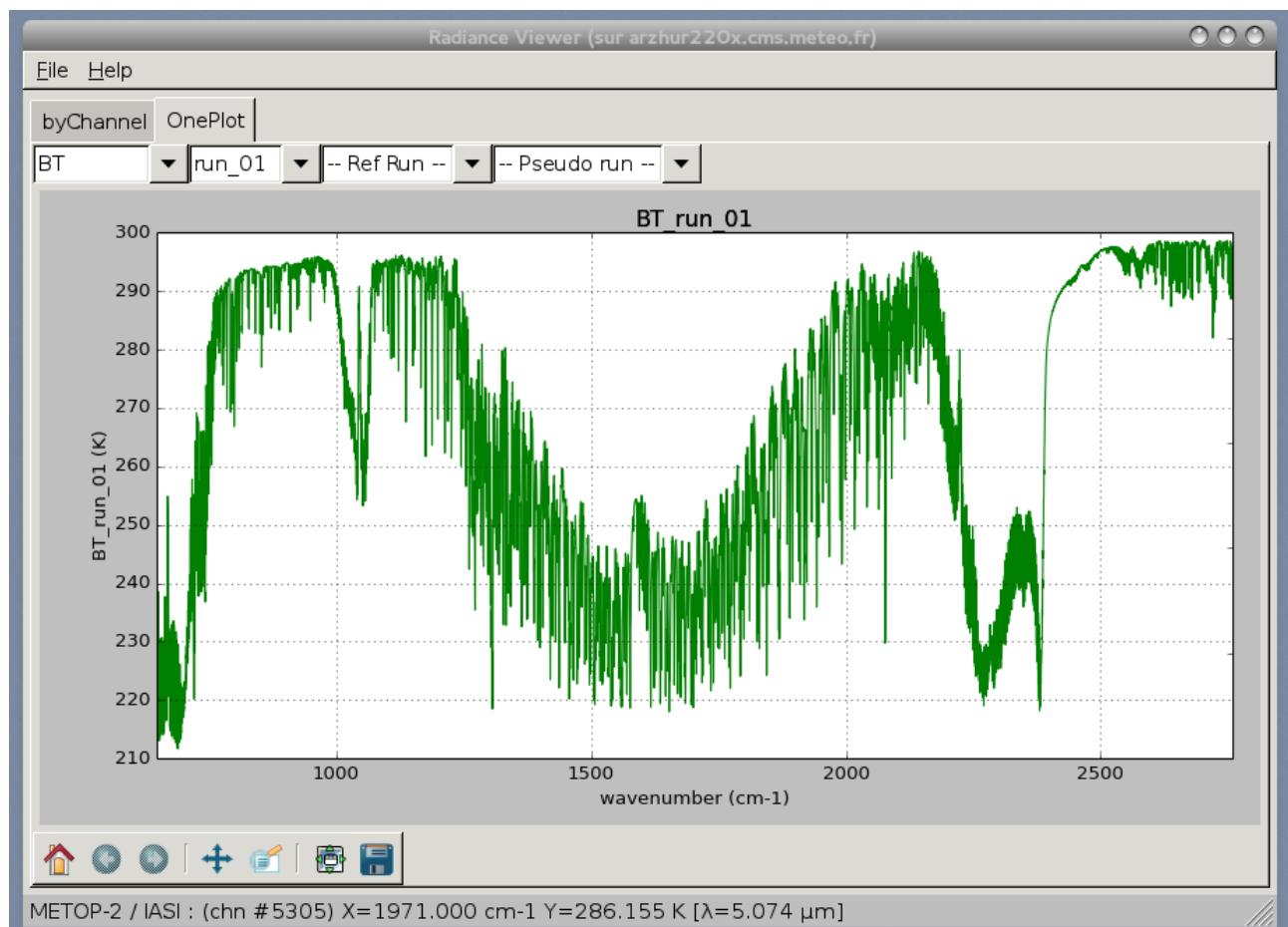
Figure 2.9.5 : Radiance window for hyperspectral instruments

For any subsequent run you can select pseudo run such as "run 02 minus run 01" or "nun 02 versus run 01" to see the spectrum differences (see fig. 2.9.6 spectrum difference between run 02 (with addsolar) and run 01(without addsolar).

You must keep the Radiance Viewer window open between runs in order to compare results from multiple runs. Once the Radiance Viewer window has been closed previous results are lost.

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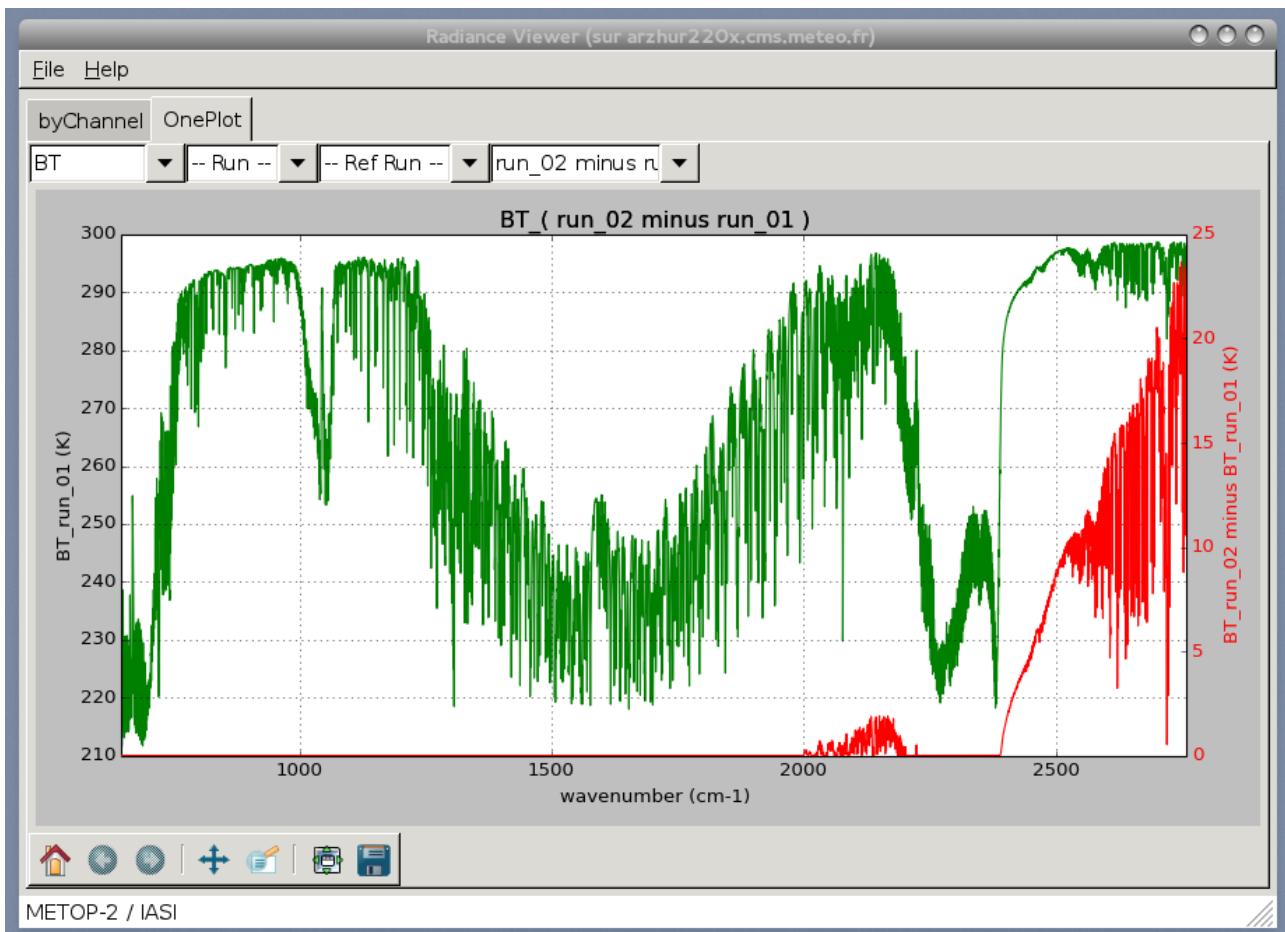
Figure 2.9.6 : Radiance window for hyperspectral instruments : difference between 2 runs (with and without addsolar)

Instrument change or channel selection:

If you change the instrument by loading a new coefficient file, or if you select channels with the "Select Channels" command of the RTTOV menu, the active radiance window which displays the results of a previous RTTOV run will be closed by RTTOV-GUI.

Radiance window command line functionality :

It is also possible to launch the radiance window separately from the RTTOV GUI with the radr.h5 file containing the results of a RTTOV run (this file are kept by default in the $HOME/.rttov directory) :

$ python rview/radianceframe.py radr.h5 [radr2.h5 ...]

Interactive navigation :

The toolbar at the bottom of the radiance window is the standard matplotlib tool bar : it allows you to zoom and navigate the figure and save plots as image files.

2.10. Running RTTOV K and working with the K-Matrix Frame

It is possible to run the K model of RTTOV. For this purpose, select the RTTOV menu from the main window and then select "Run RTTOV K". This will save and overwrite the profile and run the K model.

If the run is successful, a new window appears : the K-Matrix Window which display the result of the RTTOV K-Model (Fig 2.10.1). With every RTTOV K run, a new window is displayed.
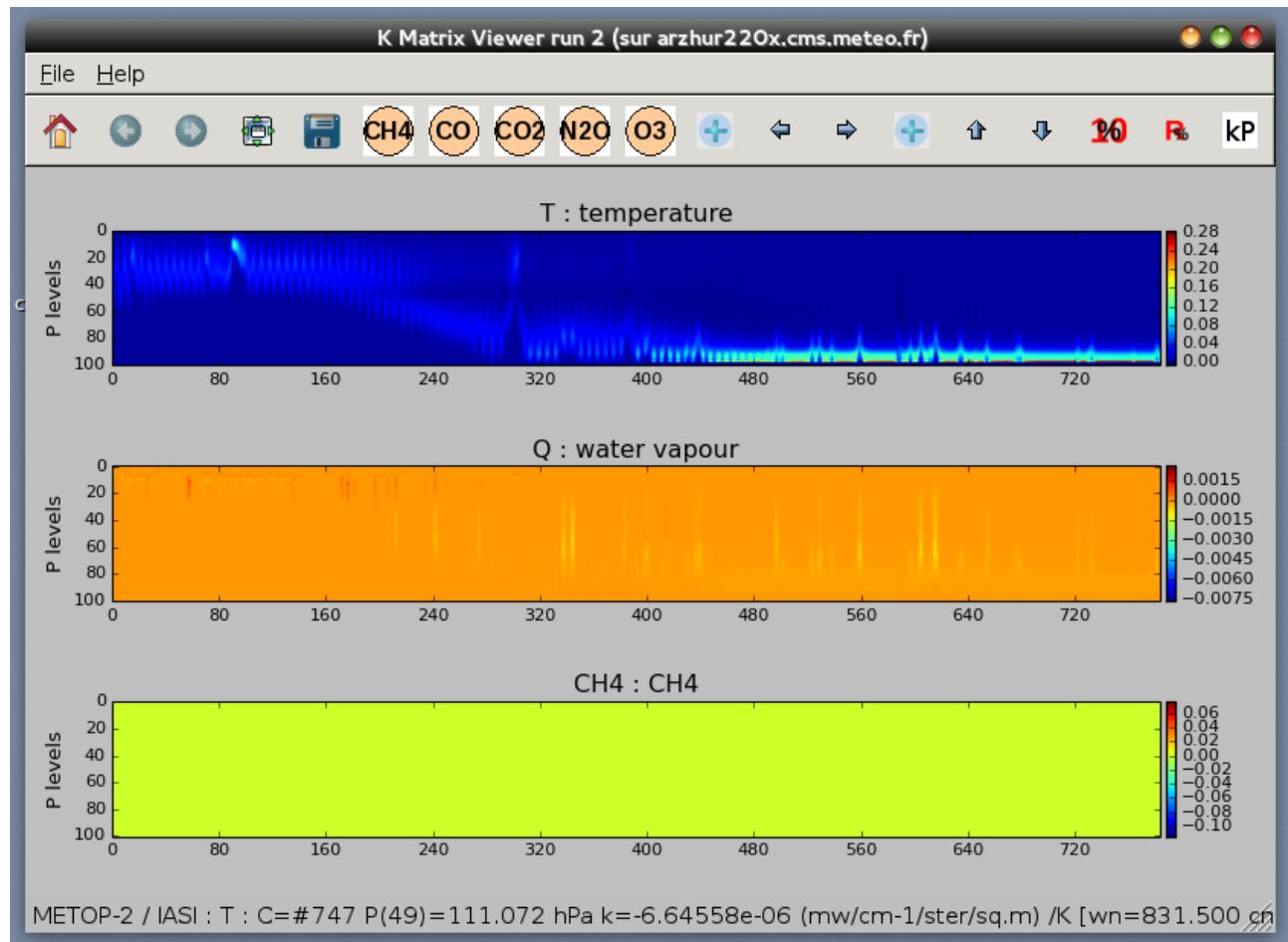
Figure 2.10.1 : K-Matrix window

Move the mouse on a channel and hit 'P' on your keyboard to display the K profile (Fig 2.10.2)

Icon toolbar :

kP

You can also use the Kp icon to choose the channel of the K profile to be displayed.

This icon permits to multiply KProfile values by 10% of input profile; only applicable to gaz variables.

If present these icons permit you to display the K matrix for different gases in the bottom plot.
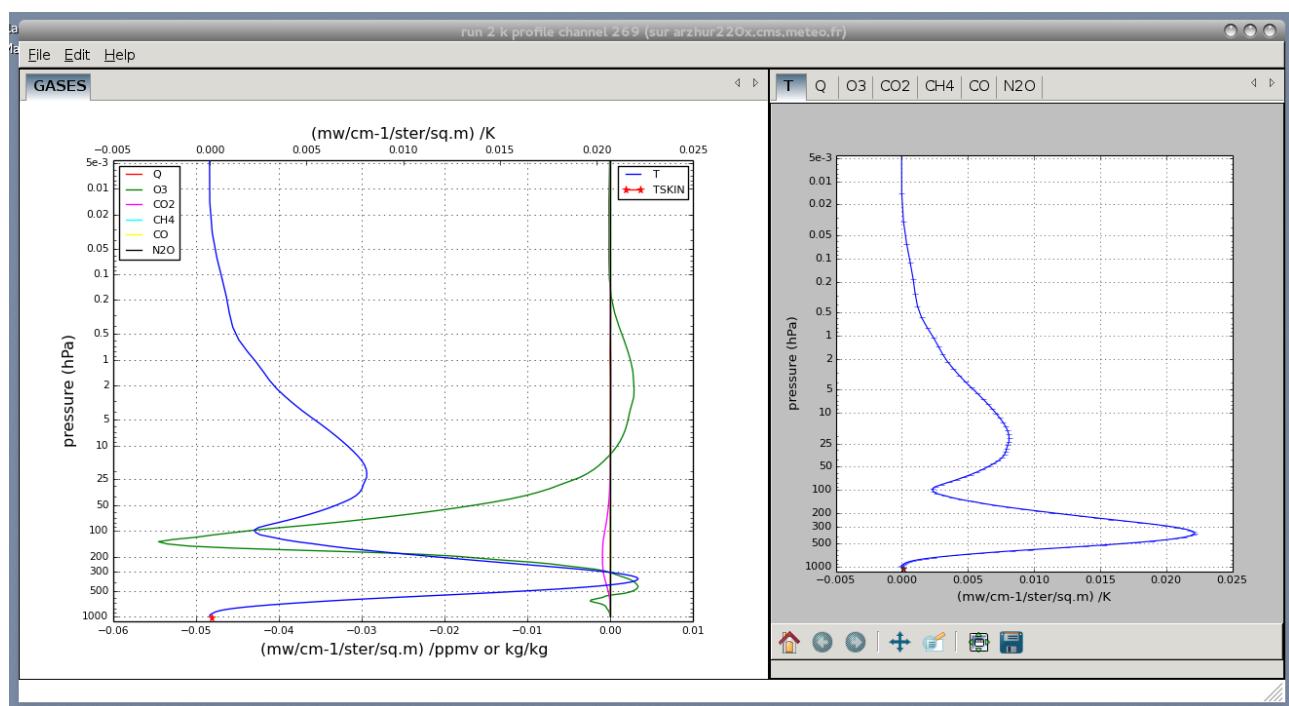
Figure 2.10.2 : The K profile window

2.11. Running PC-RTTOV (Principal Components)

It is possible to run PC-RTTOV. For this purpose you have to load a PC coefficient file and select the "addpc" option in the Option Window.

Then select "Run RTTOV" . You will be asked to enter the number of Principal Components.

After the run a new window is displayed : the PC SCORES window (Fig 2.11.1).
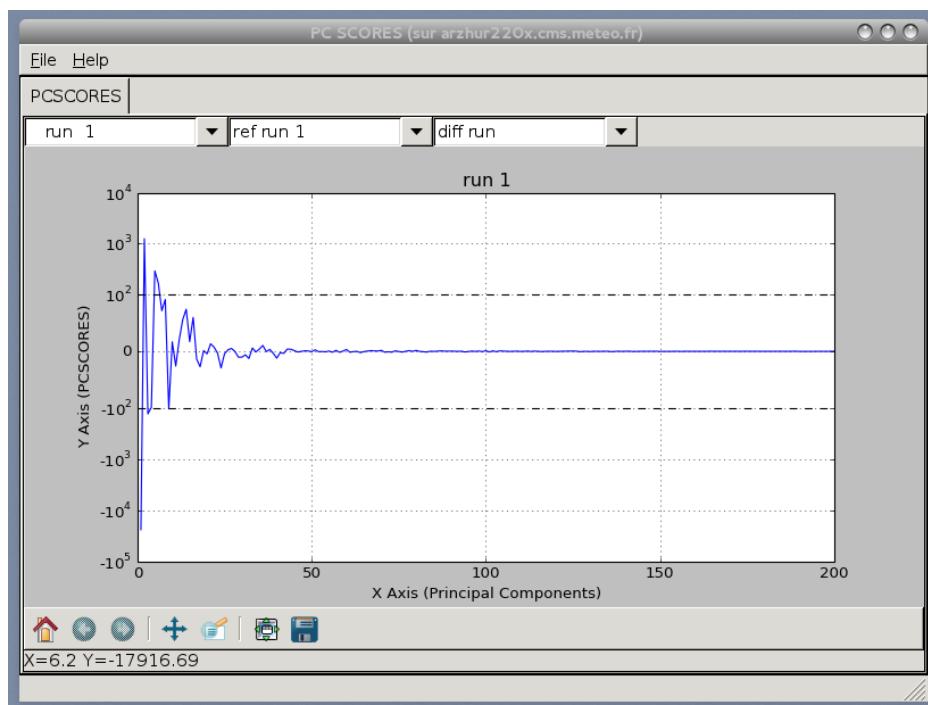
Figure 2.11.1: The PC SCORES window. Note the symmetrical log axis for pcscores. (range [-100,100] is linear)

If you choose the "addradrec" option in the option window, the result of the RTTOV Run PC is also displayed in the Radiance Window.

2.12. Running PC-RTTOV K

If you choose to run PC-RTTOV K , two windows are displayed : the KPCMatrix Window and the KPC profile window.

The KPC profile window (Fig 2.12.1) allows you to visualize the KPC profiles. You can use the sliders in order to modify the plot (first curve to be displayed and the number of curves displayed). With every K PC run, new windows are displayed.
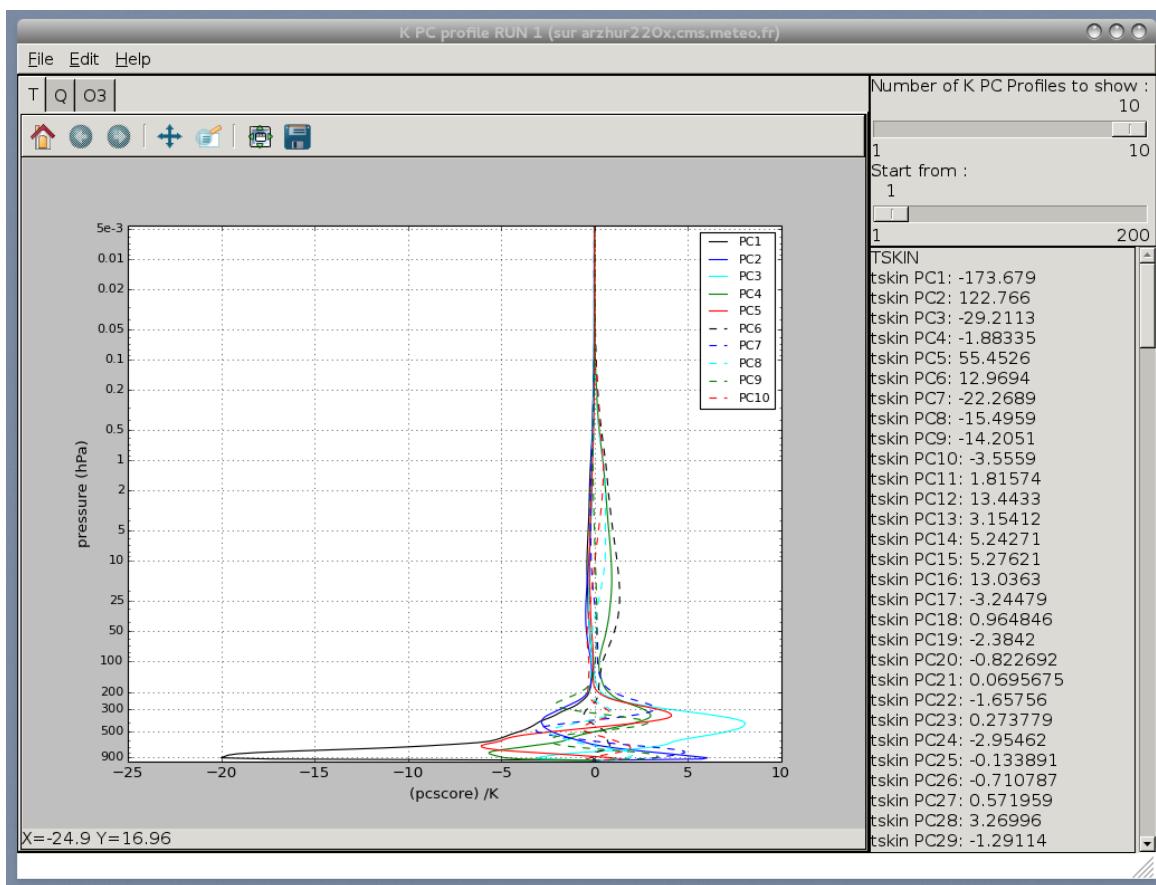
Fig 2.12.1 : The K PC profile window

2.13. Colour customisation

Matplotlib colours for the different windows can be customised : You can modify the rview/colors.py file as your convenience in respect of the python syntax.

3. 1Dvar functionalities

3.1. Introduction

There is a basic 1DVAR retrieval algorithm available with RTTOV-GUI. It uses the R-matrix and B-matrix of the NWPSAF-1DVAR retrieval software (see https://nwpsaf.eu/deliverables/1dvar/index.html). In order to be independent from this software, samples of these matrices are available in the RTTOV-GUI directory.

The basic 1DVAR algorithm can only be used for the following instruments :

"airs","iasi","amsua","amsub","mhs","hirs","atms","ssmis","cris"

The observation error R-matrix for iasi metop 2 and iasi metop 1 are identical.

Only one R-matrix for SSMIS is provided.

In order to have access to the 1Dvar functionalities, you have to open a 54 levels profile (the background error matrix are only available for 54 levels) and load the coefficients for one of the previous listed instrument.

With these to prerequisites, you have access to the Configure 1Dvar command of the 1Dvar menu of the main window (see fig 3.1.1)

3.2. Running the RTTOV-GUI 1DVAR

RTTOV-GUI 1DVAR works with 2 profiles : a Background profile "Xb" and a True profile "Xt"
The Background Profile is opened in the main RTTOV-GUI window and can be modified as usual.
The True Profile is opened in the specific 1DVAR window (Fig 3.1.1) and cannot be modified.
If you change the coefficient file with RTTOV-GUI the 1DVAR window is reinitialized.
It is also possible to run the RTTOV-GUI 1DVAR basic algorithm without running the whole RTTOV-GUI :
example :

```
$python rcontroller/r1dvarController.py \
-P=${RTTOV_GUI_PROFILE_DIR}/standard54lev_allgas.H5 \
-s=${RTTOV_GUI_COEFF_DIR}/rttov7pred54L/rtcoef_noaa_19_amsua.dat
```

The 1DVAR window is initialized in this case with the first profile of

${RTTOV_GUI_PROFILE_DIR}/standard54lev_allgas.H5.
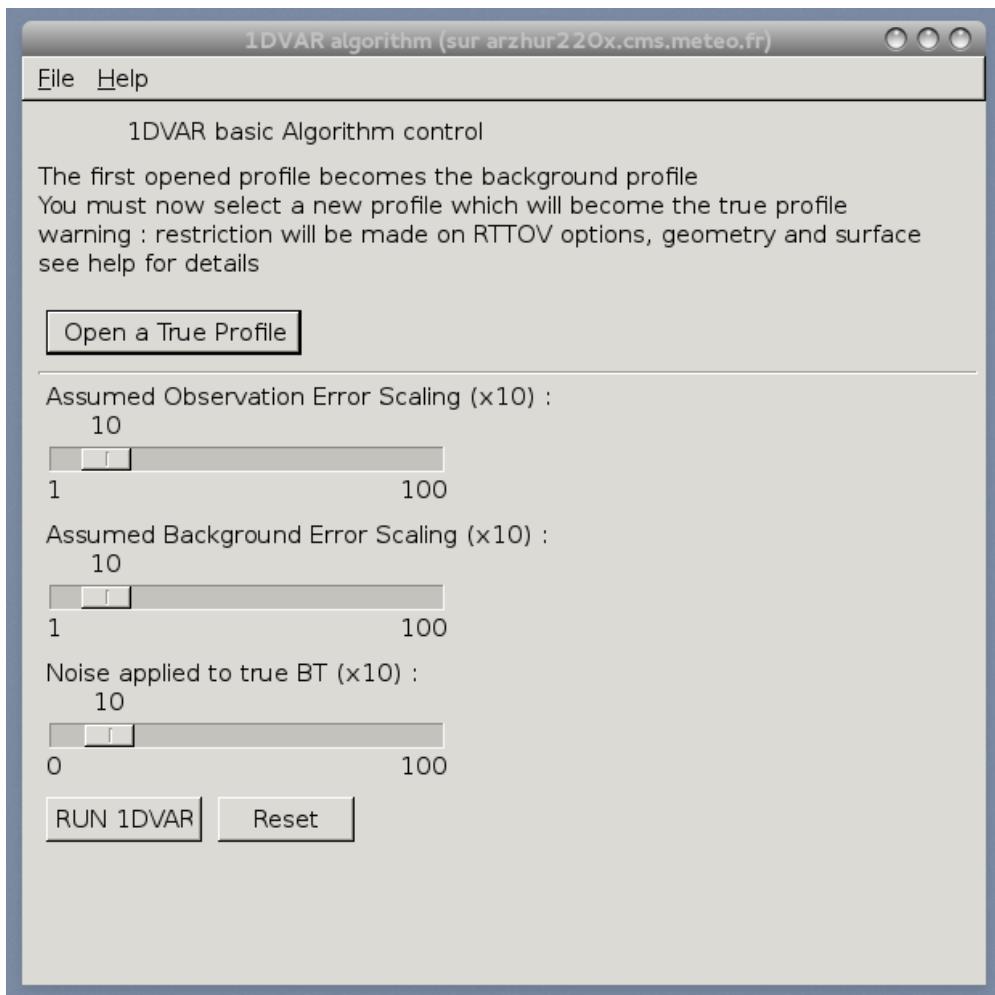
Fig 3.1.1 : The 1Dvar window

3.3. Algorithm Description

Restrictions :

- This algorithm works with fixed profile levels (54)

- RTTOV computations are made with no cloud,nor aerosols, nor trace gas (just T and Q)

- All surface variables except Tskin and T2m are fixed for the true profile and equal to those of the background profile.

- The surface type is forced to "sea"

- all RTTOV calculations are made at nadir

Inputs / selections :

When you configure the 1DVAR the R-matrix and B-matrix are read in the ${RTTOV_GUI_PREFIX}/r1DVAR/data directory

It is possible to configure the environment variable NWPSAF_1DVAR_HOME if you want to use another directory (but do not change the sub-directories names and file formats).

1. Open a true profile Xt selected from the database

2. Change the value of the scaling factor (fb) for the background errors if necessary

3. Change the value of the scaling factor (fr) for the observation errors if necessary

4. Change the value of the maximum random noise if necessary

5. Click on the RUN 1DVAR button

Computations made by RTTOV-GUI :

1. Compute brightness temperatures Y(Xt) from Xt (made only at the first step)

2. Compute and add random noise vector N to Y(Xt) (made only at the first step)

3. Compute brightness temperatures Y(Xb) from Xb

4. Compute jacobian matrix K(Xb) and transpose KT(Xb)

5. Apply scaling factor to background errors B --> fb x B (applied each step to the original B-matrix)

6. Apply scaling factor to observation errors R --> fr x R (applied each step to the original R-matrix)

7. Compute linear 1DVAR weights W where W = B . KT . [K .B . KT + R](-1)

8. Compute linear 1DVAR retrieved profile (Xr) Xr = Xb + W . [(Y(Xt) + N) - Y(Xb)]

The results are displayed in 2 windows :

A profile window (Fig 3.2.1) : display the True, the Background and the Retrieved profiles; a brightness temperature window (FIG.3.2.2) display Y(Xt)+Noise, Y(Xt) and Y(Xb).

It is possible to make a maximum of 9 Runs of retrieval.
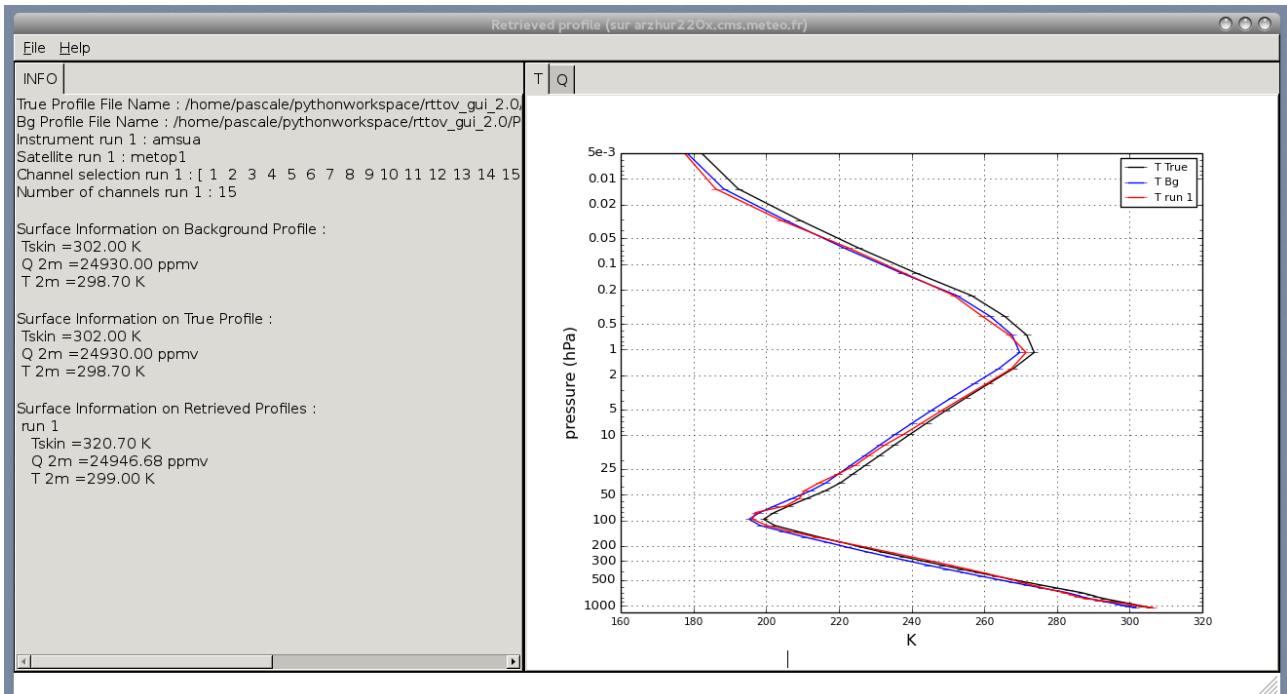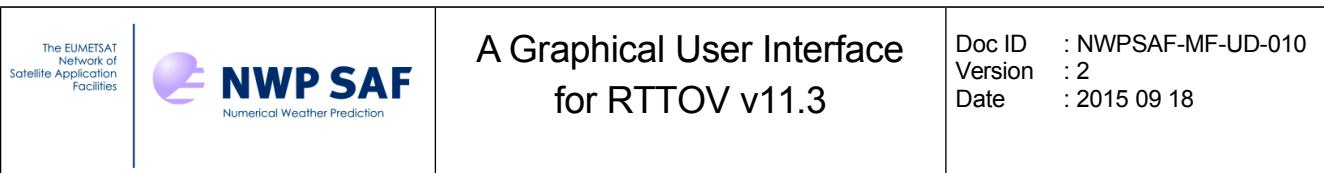
Fig 3.2.1 (Retrieved profile window)
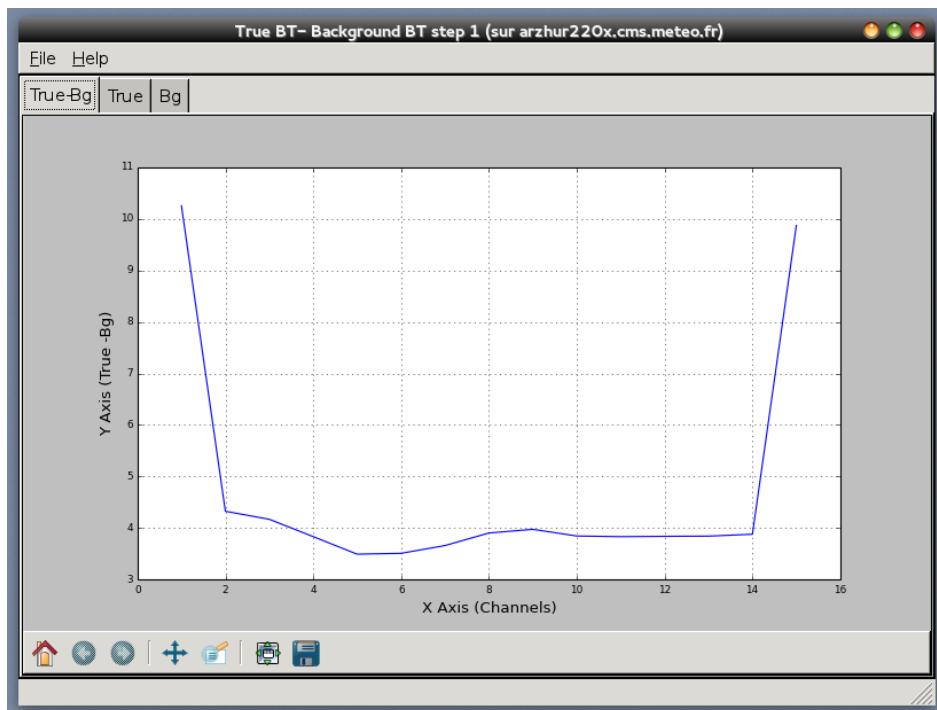
Fig 3.2.2 (True BT – Background BT)

By clicking the reset button : the 1DVAR window is reinitialized : the background profile is reinitialized (if you a have made some changes on it with the surface window and/or the profile window).

4. Input Profile file format

The input profiles for the RTTOV GUI can be of two different kind formats. The "native" profile format is HDF5, as the Fortran executable GUI command will only read such format. The other format is an ASCII format made of Python statements for the required variables. The two formats are described below.

4.1. HD5 profile file format

The HDF5 profile format can store a single profile or a profile dataset such as the ECMWF diverse 83 profile set. It also allows RTTOV options to be stored in the same file.

The HDF5 top level structure is as follows (note all groups and datasets are in capital letters):

```
/PROFILES              Group
/PROFILES/0001         Group     First profile
/PROFILES/0002         Group     Optional
....
/PROFILES/9999         Group     Optional
/OPTIONS               Group     Optional
```

The /PROFILES/0001 group contains a copy of the RTTOV profile structure (see the module src/main/rttov_type.F90 and RTTOV user's guide). If the HDF5 file contains several profiles they should be numbered continuously and the group name is made of 4 digits with leading zeros. Under the profile number group the variable names are HDF5 datasets (capital letters). The skin and s2m sub-structures are HDF5 subgroups which contain the variables corresponding to those sub-types of the RTTOV profile structure; see the table below.

Name	HDF5 type	Dimension	Comment
ID	Dataset	{SCALAR}	
DATE	Dataset	{3}	
TIME	Dataset	{3}	
NLAYERS	Dataset	{1}	
NLEVELS	Dataset	{1}	
CTP	Dataset	{1}	

CFRACTION	Dataset	{1}	
CLOUD	Dataset	{nlayers,6}	optional
CFRAC	Dataset	{nlayers}	optional
ICEDE	Dataset	{nlayers}	optional
IDG	Dataset	{1}	
ISH	Dataset	{1}	
CLW			optional, never used in GUI
AEROSOLS	Dataset	{nlayers,13}	optional
P	Dataset	{nlevels}	
T	Dataset	{nlevels}	
Q	Dataset	{nlevels}	
O3	Dataset	{nlevels}	optional
CO2	Dataset	{nlevels}	optional
N2O	Dataset	{nlevels}	optional
CO	Dataset	{nlevels}	optional
CH4	Dataset	{nlevels}	optional
BE	Dataset	{1}	
COSBK	Dataset	{1}	
SNOW_FRAC	Dataset	{1}	
SOIL_MOISTURE	Dataset	{1}	
LATITUDE	Dataset	{1}	
LONGITUDE	Dataset	{1}	
AZANGLE	Dataset	{1}	
ZENANGLE	Dataset	{1}	
SUNAZANGLE	Dataset	{1}	

SUNZENANGLE	Dataset	{1}	
ELEVATION	Dataset	{1}	
S2M	***Group***		
S2M/O	Dataset	{1}	
S2M/P	Dataset	{1}	
S2M/Q	Dataset	{1}	
S2M/T	Dataset	{1}	
S2M/U	Dataset	{1}	
S2M/V	Dataset	{1}	
S2M/WFETC	Dataset	{1}	
SKIN	***Group***		
SKIN/FASTEM	Dataset	{5}	
SKIN/FOAM_FRACTION	Dataset	{1}	
SKIN/SALINITY	Dataset	{1}	
SKIN/SURFTYPE	Dataset	{1}	
SKIN/T	Dataset	{1}	
SKIN/WATERTYPE	Dataset	{1}	

The /OPTIONS group contains a copy of the RTTOV option structure (see the module src/main/rttov_type.F90 and RTTOV user's guide). There is only one option structure in the HDF5 file even if several profiles are stored in. This /OPTIONS group is optional. All RTTOV options variables should be present. The logical variables are converted to integer datasets where "true" is converted to 1 and "false" converted to 0. Note that the RTTOV options substructures are packed all together in the same group.

Name	**HDF5 type**	**Dimension**
APPLY_REG_LIMITS	Dataset	{1}
VERBOSE	Dataset	{1}
DO_CHECKINPUT	Dataset	{1}

ADDPC	Dataset	{1}
ADDRADREC	Dataset	{1}
IPCBND	Dataset	{1}
IPCREG	Dataset	{1}
ADDREFRAC	Dataset	{1}
SWITCHRAD	Dataset	{1}
USE_Q2M	Dataset	{1}
DO_LAMBERTIAN	Dataset	{1}
ADDSOLAR	Dataset	{1}
DO_NLTE_CORRECTION	Dataset	{1}
ADDAEROSL	Dataset	{1}
ADDCLOUDS	Dataset	{1}
USER_AER_OPT_PARAM	Dataset	{1}
USER_CLD_OPT_PARAM	Dataset	{1}
CLDSTR_THRESHOLD	Dataset	{1}
CLDSTR_SIMPLE	Dataset	{1}
OZONE_DATA	Dataset	{1}
CO2_DATA	Dataset	{1}
N2O_DATA	Dataset	{1}
CO_DATA	Dataset	{1}
CH4_DATA	Dataset	{1}
FASTEM_VERSION	Dataset	{1}
CLW_DATA	Dataset	{1}
SUPPLY_FOAM_FRACTION	Dataset	{1}
ADDINTERP	Dataset	{1}

INTERP_MODE	Dataset	{1}
LGRADP	Dataset	{1}
REG_LIMIT_EXTRAP	Dataset	{1}
SPACETOP	Dataset	{1}

4.2. ASCII Text profile file

The RTTOV GUI is able to read an ASCII text profile file. This kind of file is made of Python statements for the required variables. Thus the format should respect the Python language syntax. The arrays should be defined as NumPy arrays, the scalars can be pure Python scalars or NumPy variables.

The variable names are the ones described in the RTTOV users guide for the profile structure (Annex O), capital letters; except for:

- clouds where 2D cloud array is replaced by 1D cloud arrays, one for each cloud short name (table 22 of users guide)
- aerosols where 2D aerosols array is replaced by 1D aerosol arrays, one for each aerosol short name (table 23 of users guide)

Units are as described in RTTOV users guide for profile structure (Annex O).

Pressure, temperature and water vapour arrays are mandatory; all other RTTOV profile variables are optional, they will be set to default values when the profile is read.

The list of profile variables that can be set by the user is given below with the default values. Omitted values default to a clear atmosphere. The number of levels and layers are deduced from array sizes.

```
#" Mandatory arrays: P (hPa), T(K), Q(ppmv) on levels"
self["P"] = numpy.array([...])
self["T"] = numpy.array([...])
self["Q"] = numpy.array([...])


#"----------------------------------------"
#" Optional profile variables "
#"----------------------------------------"


#" Other Gases (ppmv on levels)"
self["O3"]  = numpy.array([...])
self["CO2"] = numpy.array([...])
```

```
self["CH4"] = numpy.array([...])
self["CO"]  = numpy.array([...])
self["N2O"] = numpy.array([...])


#" Aerosols (1/cm3 on layers)"
self["INSO"] = numpy.array([...]) # Insoluble
self["WASO"] = numpy.array([...]) # Water soluble
self["SOOT"] = numpy.array([...]) # Soot
self["SSAM"] = numpy.array([...]) # Sea salt (acc mode)
self["SSCM"] = numpy.array([...]) # Sea salt (coa mode)
self["MINM"] = numpy.array([...]) # Mineral (nuc mode)
self["MIAM"] = numpy.array([...]) # Mineral (acc mode)
self["MICM"] = numpy.array([...]) # Mineral (coa mode)
self["MITR"] = numpy.array([...]) # Mineral transported
self["SUSO"] = numpy.array([...]) # Sulphated droplets
self["VOLA"] = numpy.array([...]) # OPAC Volcanic ash
self["VAPO"] = numpy.array([...]) # New Volcanic ash
self["ASDU"] = numpy.array([...]) # Asian dust


#" Clouds (g/m3 on layers)"
self["STCO"] = numpy.array([...]) # Stratus Continental
self["STMA"] = numpy.array([...]) # Stratus Maritime
self["CUCC"] = numpy.array([...]) # Cumulus Continental Clean
self["CUCP"] = numpy.array([...]) # Cumulus Continental Polluted
self["CUMA"] = numpy.array([...]) # Cumulus Maritime
self["CIRR"] = numpy.array([...]) # Cirrus
self["CFRAC"]= numpy.array([...]) # Cloud Fraction (should be set if any cloud)
self["IDG"]  = 1   # Scheme for Ice water content
self["ISH"]  = 1   # Ice cristal shape


#" Skin variables "
self["SKIN"]["T"]         = self["T"][-1]  # (K)
self["SKIN"]["SURFTYPE"]  = 1  # (0=Land, 1=Sea, 2=sea-ice)
self["SKIN"]["WATERTYPE"] = 1  #  (0=fresh water, 1=ocean water)
self["SKIN"]["SALINITY"]  = 37 # (%o)
self["SKIN"]["FASTEM"]    = numpy.array([0., 0., 0., 0., 0.]) # (5 parameters
```

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Facilities

```
Land/sea-ice)


#" 2m and 10m air variables "
self["S2M"]["T"] = self["T"][-1] # (K)
self["S2M"]["Q"] = self["Q"][-1] # (ppmv)
self["S2M"]["P"] = self["P"][-1] #  (hPa)
self["S2M"]["U"] = 0 #  (m/s)
self["S2M"]["V"] = 0 #  (m/s)
self["S2M"]["WFETC"] = 100000 #  (m)


#" Simple cloud "
self["CTP"]       = 500.0 # (hPa)
self["CFRACTION"] = 0.0 # [0,1]    Clear sky is the default


#" Viewing geometry "
self["AZANGLE"]     = 0. # (deg)
self["ELEVATION"]   = 0. # (km)
self["LATITUDE"]     = 49.738  # (deg)  Lannion is 48.750,  -3.470
self["LONGITUDE"]    = -3.473  # (deg)  Exeter is  50.726,  -3.476


self["SUNAZANGLE"]  = 0. # (deg)
self["SUNZENANGLE"] = 0. # (deg)
self["ZENANGLE"]    = 0. # (deg)
self["SNOW_FRAC"]   = 0. # [0,1]


#" Magnetic field "
self["BE"]    = 0.3 # (Gauss)
self["COSBK"] = 1.


#" Mislaneous "
self["ID"]="This is my profile"
self["DATE"] = numpy.array([2014, 04, 30], dtype=int) # Year, Month, Day
self["TIME"] = numpy.array([12, 0, 0], dtype=int)     # Hour, Minute, Second
```

4.3. How to create an HDF5 profile file from Fortran

RTTOV users can create an HDF5 profile file for use in the RTTOV GUI using the RTTOV subroutine RTTOV_HDF_SAVE contained in src/hdf/rttov_hdf_mod.F90. This subroutine can write any RTTOV structure to an HDF5 file.

For example a main Fortran program that can store a profile dataset and options in the same file would contain the following statements:

```fortran
Use hdf5
Use rttov_hdf_mod
Type(profile_type),      Pointer :: profiles(:)         => NULL()
Type(rttov_options) :: opts


CALL OPEN_HDF( .TRUE., ERR )
!... statements that creates the profiles array
!... and statements that fills the options opts
CALL RTTOV_HDF_SAVE( ERR, "PROFILES.H5", '/PROFILES', &
        CREATE=.true., PROFILES = profiles(1:nprofiles))
CALL RTTOV_HDF_SAVE( ERR, "PROFILES.H5", '/OPTIONS', CREATE=.false., &
        OPTIONS = opts )
CALL CLOSE_HDF( ERR )
```

4.4. How to create an HDF5 profile file from ASCII text profile file

The ASCII text profile files are Python files. A Python script named convert_python2hdf.py in the rttov_test/profile-datasets/ directory allows the user to convert an ASCII text profile to an HDF5 profile file. This script makes use of RTTOV GUI Python software (Profile class), so cannot be used outside this framework.

```
usage: convert_python2hdf5.py [-h] -i INPUTF [-o OUTPUTF]
                                          [-g GROUP] [-v]


Import ASCII profile to HDF5 for RTTOV GUI


optional arguments:
  -h, --help            show this help message and exit
  -i INPUTF, --input-file INPUTF
                        input file name
  -o OUTPUTF, --output-file OUTPUTF
                        output file name
  -g GROUP, --group GROUP
                        internal HDF5 default is /PROFILES/0001/
  -v, --verbose         display profile variables
```

It is possible to convert all of the RTTOV test suite profile datasets contained in rttov_test/profile-datasets/ to ASCII and HDF5 format quite easily. Navigate to the rttov_test/profile-datasets/ directory and then run:

```
$ ./run_convert_test2python.sh
$ ./run_convert_python2hdf5.sh
```

These scripts create profile-datasets-py/ and profile-datasets-hdf/ directories within rttov_test/ containing all of the RTTOV test suite profiles in Python ASCII and HDF5 formats for input to the GUI.

Note that the second of these two scripts requires the gui/rttov/ directory to be in your PYTHONPATH and rttov_gui_f2py.so must be linked in the profile-datasets/ directory.

5. Reporting bugs and limitations

All main RTTOV GUI actions are logged in a file named "rttovgui.log" in the RTTOV_GUI_WRK_DIR directory. If the user encounters an issue during the RTTOV GUI usage, he should exit the program and copy the log file to a new name. This log file should be attached to any request to the help-desk or forum. We encourage the users to share experiences through the RTTOV forum at http://www.nwpsaf.eu/forum/

Restrictions:
– It is not possible to enter explicit cloud/aerosol optical parameters profiles for each channel.
– The RTTOV GUI is not compatible with RTTOV-SCATT.

Known bugs or current limitations:
– For the K calculations : only atmospheric gases, atmospheric temperature and TSkin variables are displayed.