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RTTOV GUI : Addition of 1D-VAR retrieval to RTTOV-GUI http://nwpsaf.eu/deliverables/rtm/



Introduction

RTTOV-GUI is a graphical user interface for the radiative transfer model RTTOV (1) developed in the context of the NWP-SAF EUMETSAT project and is included in the RTTOV package (since version 11.2).

It allows to run the RTTOV direct and Jacobian models and PC-RTTOV (direct and Jacobian) for one atmospheric profile and for all instruments permitted by RTTOV.

The RTTOV-GUI was designed for educational purposes and was used in the NWP-SAF's satellite data assimilation training course.

1DVAR Functionality : The last version of RTTOV-GUI includes an 1D-VAR retrieval functionality. The algorithm is based on the NWP-SAF 1D-VAR retrieval package scheme.

RTTOV GUI under the hood :

RTTOV GUI is written in python (2.7) and use :

wxPython : open source GUI framework based on the powerful wxWidget toolkit **numpy** : python package for scientific computing

matplotlib : python package for 2D plotting

f2py : allows to call fortran routines from python

h5py : the interface between RTTOV and RTTOV GUI is working with HDF5 files :

- profile.h5 : contains vertical profile, and options for RTTOV

- surface.h5 : contains RTTOV input/output Emissivity/BRDF

It allows visualizing retrieved T and Q profiles from a user-defined profile and background and observation error covariances (2).

(1) See also 2p.01. RTTOV development status

(2) Background and observation error covariances matrices are inherited from the NWP-SAF 1D-VAR retrieval package, they can be customized if necessary : see the NWP-SAF 1D-VAR retrieval package documentation (https://nwpsaf.eu/deliverables/nwpsaf_1dvar/index.html)

Main features

Step 1 : open a profile file (hdf5 or ascii) and select coefficient files.

../profile-datasets-py/cldaer101lev_allgas/001 👌 🔘 🕂 👉 🖉 📳 S2M parameters 000 TIME 00:00:00 T 298.700 <u>File Windows Rttov 1Dvar Help</u> LATITUDE 47.400 Q 24930.00 ONGITUDE 10.927 ipcreg 0 0.029 addradrec P 950.000 ELEVATION 0.000 apply_reg_limits addrefrac AZANGLE 0.000 U 5.000 MW-only RT options verbose switchrad V 2.000 ZENANGLE 45.000 fastem_version 🗹 do_checkinput ⊡use q2m clw data JNAZANGLE 179.000 WFETC 100000.0 🗌 do lambertiar do_lambertian NZENANGLE 40.000 SKIN parameters VIS/IR-only RT options PC-RTTOV options supply_foam_fraction F CFRACTION 0.600 SURFTYPE and addsolar do_nlte_correction WATERTYPE fresh water nterpolation and vertical grid options BE 0.201 addinterp 👻 ipcreg COSBK 0.000 T 302.000 interp mode CTP 949.000 SALINITY 35.000 spacetop cldstr_threshold MW-only RT options lgradp IDG Ou and Liou 🔻 FOAM FRACTION 0 000 🗌 ozone_data reg_limit_extrap 🚽 fastem_versio ISH Hexagonal crystals 🔻 Fastem parameters co2_data SNOW_FRAC 0.000 Default n2o data 015/10/19 12:06:11 Start Direct IL_MOISTURE 0.000 co_data 2015/10/19 12:06:11 End Direct Interpolation and vertical grid options ch4_data Revert Apply 🗹 addinterp 2015-10-19 12:06:11 rttov_gui_run completed return code: 0 5 Rochon/Log-lin WF 🔻 interp_mode 015-10-19 12:06:11 rttov run mode DIRECT ok 🗹 spacetop 🗌 Igradp 015-10-19 12:06:11 openSurface /home/pascale/.rttovdev/surface.h5 ☑ reg_limit_extrap '2015-10-19 12:06:11', 'Radiance Viewer', ' : read file : /home/pascale/.rttovdev/radr.h5 Revert Apply ('2015-10-19 12:06:11', 'Radiance Viewer', 'MSG-4 / SEVIRI : addSolar=False. Refl hidden.') 2015-10-19 12:06:12'. 'Radiance Viewer'. 'MSG-4 / SEVIRI : End init : 0.499143 sec.') **Options window RTTOV GUI main window** where you can launch commands and visualize Choose an instrument the log. <u>File Edit H</u>elp by selecting RTTOV GASES AEROSOLS Q 03 C02 CH4 C0 N20 INSO WASO S coefficient files Temperature (K)

- radr.h5 : radiances and BT/reflectances computed by RTTOV - kmat.h5 : contains the K matrix computed by RTTOV

Step 2 : modify options, surface parameters, viewing angles and the atmospheric profile if necessary with the surface window, the option window, and the profile editor window.





Step 3 : run RTTOV :

direct model or K model.

Radiance window : when you run the direct model, RTTOV GUI displays the result of RTTOV in the radiance window, you can visualize radiances, brightness temperatures and reflectances computed by RTTOV and visualize the difference between 2 runs.

000



model, RTTOV-GUI displays the K matrix, you can visualize also the K profile by

button)



1D-Var functionality



the 1DVAR window allows you to

run the 1DVAR algorithm

1DVAR basic Algorithm control

Assumed Observation Error Scaling (x10)

Assumed Background Error Scaling (x10)

Reset

Noise applied to true BT (x10)

RUN 1DVAR

The first opened profile becomes the background profile

You must now select a new profile which will become the true profile

100

100

100

warning : restriction will be made on RTTOV options, geometry and surface

<u>F</u>ile <u>H</u>elp

see help for details

Open a True Profile

1DVAR algorithm (sur arzhur220x.cms.meteo.fr)



Before running the 1Dvar, you can run RTTOV K in order to visualize at which level a channel may be useful for the retrieval. You can also visualize the K profile for a specific channel : we can see that the 12th channel of AMSUA will be useful at 10 hPa.

How to use the 1DVAR functionality?

- Run RTTOV GUI with a 54 levels profile : it will be considered as the background profile : you can modify it with the profile editor window. - Select an instrument in the following list : AMSUA, MHS, ATMS, HIRS, AIRS, CrIS, IASI, SSMIS and load a 54 levels coefficient file. - Select from the 1Dvar menu the Configure 1Dvar command.

BT CLEAR run 02

wavenumber (cm-1)

Work now from the 1Dvar window :

1. Open a true profile (Xt)

wavenumber (cm-1)

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 2. Compute and add random noise vector N to Y(Xt) 3. Compute brightness temperatures Y(Xb) from Xb 4. Compute jacobian matrix K(Xb) and transpose $K_{T}(Xb)$ 5. Apply scaling factor to background errors B --> fb x B 6. Apply scaling factor to observation errors R --> fr x R 7. Compute linear 1DVAR weights W where W = B . K_{T} . [K .B . K_{T} + R]⁻¹ 8. Compute linear 1DVAR retrieved profile (Xr) Xr = Xb + W . [(Y(Xt) + N) - Y(Xb)]



Select channels channel 1 channel 2 channel 3 channel 4 channel 5 channel 6 channel 7 channel 8 channel 9 channel 10 channel 11 🗹 channel 12 channel 13 channel 14 🗌 channel 15 <u>0</u>K <u>C</u>ancel

The RTTOV menu of the main window allows you to select one or several channels from the selected coefficient file. Here the user wants the 12th channel.