NWP SAF

RTTOV Version 13.0
Release Note

Version 1.0

18th September 2020

RTTOV Version 13.0 Release Note

This documentation was developed within the context of the EUMETSAT Satellite Application Facility on Numerical Weather Prediction (NWP SAF), under the Cooperation Agreement dated 7 December 2016, between EUMETSAT and the Met Office, UK, by one or more partners within the NWP SAF. The partners in the NWP SAF are the Met Office, ECMWF, DWD and Météo France.

Change record				
Version	**Date**	**Author**	**Approved**	**Remarks**
0.1	30/03/20	JH		First draft for v13 beta
1.0	18/09/20	JH		Updates after beta testing

Table of Contents

1. DOCUMENTATION

The following user documentation is included in the RTTOV package:

- *NWPSAF_ReleaseNote_RTTOV13.0* - this document
- *users_guide_rttov13_v1.0.pdf* - user guide giving full details of how to compile and run RTTOV and how to incorporate it into the user's application
- *rttov-quick-start.pdf* - beginner's guide to getting started with RTTOV
- *rttov_gui _v13.pdf* - user guide for RTTOV GUI
- *rttov-wrapper.pdf* - user guide for the C++/Python interface to RTTOV
- *rttov-test.pdf* - detailed description of the RTTOV test suite

2. MAIN CHANGES

Detailed lists of the changes between RTTOV v13 and v12.3 are given in section 4 of the user guide. The main changes are given below.

Changes between RTTOV v13.0 and v12.3:

General:

- New optical depth coefficient files are available based on an updated ("v13 predictor") optical depth parameterisation and trained on LBLRTM v12.8. For visible channels this includes a new parameterisation for Rayleigh extinction which can optionally be excluded from simulations.
- The geometric altitude of each input pressure level is now available as an output in the *rttov_radiance* structure.
- Updates to allow for new polarisation in sensors like TROPICS with a fixed, but uneven mixture of H- and V-pol in each channel.

RTTOV-SCATT:

- RTTOV-SCATT allows simulations with an arbitrary number of hydrometeor types and optionally with separate cloud fraction profiles per hydrometeor.
- RTTOV-SCATT provides a new radar reflectivity simulation capability.
- New approximate treatment of polarised scattering.
- New scattering property tables.

Visible/IR scattering:

- Visible DOM simulations can optionally include full Rayleigh multiple scattering.
- Updated cloud liquid water optical properties based on updated refractive index dataset.
- A parameterisation of cloud liquid water effective diameter has been implemented for use with the CLW "Deff" visible/IR optical properties so that input Deff values are not mandatory: the parameterisation is used where the input *clwde(:)* profile values are zero.
- For visible/IR cloud simulations, the surface-space and level-to-space cloud extinction transmittances (on the surface-satellite path and excluding gas absorption) are output in the new *tau_total_cld* and *tau_levels_cld* members of the transmission structure.
- MFASIS simulations may now be run simultaneously (in the same call) as IR scattering simulations.

Surface emissivity and reflectance updates:

- The CAMEL 2007 IR atlas now provides standard deviations from the CAMEL climatology rather than the older UWIRemis standard deviations.
- For the UWIRemis and CAMEL 2007 IR emissivity atlases, the emissivity PC scores and eigenvectors are now optional outputs from the *rttov_get_emis* subroutine.
- The profile skin specularity variable introduced in RTTOV v12.3 for use with the *do_lambertian* option has been moved into the *rttov_emissivity* structure so that it can vary per-channel. This is now also an active variable in the TL/AD/K.
- The diffuse reflectances used by RTTOV for downward emitted and downward scattered radiation are available as an output in the *rttov_reflectance* structure. The value used for the diffuse reflectance can optionally be specified by the user for visible/near-IR channels.

HTFRTC:

- New coefficients are available based on LBLRTM v12.8 in ASCII format as well as netCDF.
- Emissivities are now input on centroid (predictor) wavenumbers which is consistent with the way PC-RTTOV works.
- HTFRTC now supports RTTOV's IREMIS sea surface emissivity model.
- Optimisation of the HTFRTC direct and K models.

Technical updates:

- The GUI has been updated to work with Python3, and to support new RTTOV features including all new options, input of surface specularity, and input/output of diffuse surface reflectance.
- The Python/C++ wrapper has been updated to support new features including the RTTOV-SCATT updated passive and new active simulation capabilities.
- Optimisation of the MFASIS model, which improves performance of the direct/TL/AD/K.
- Optimisation of the RTTOV-DOM AD/K models.

3. INSTALLATION

Detailed installation instructions are provided in the user guide. A brief overview is given below.

Extraction

The RTTOV v13.0 package is named *rttov130.tar.xz*. This can be downloaded from the NWP SAF website after registering with the site and agreeing to the terms of the licence. To unpack, copy the tarball to a new directory (e.g. *~/rttov130/*) which becomes your RTTOV top-level directory, and do the following:

$ tar xf rttov130.tar.xz

Compilation

It is recommended to compile RTTOV against the HDF5 library (v1.8.8 or later) as this provides the ability to read HDF5 coefficient and land surface BRDF and emissivity atlas files, and to use the GUI. In order to do this, you must first edit the file *build/Makefile.local* to point to the location of your HDF5 installation. Usually this involves:

- specifying the path to your HDF5 build in HDF5_PREFIX
- uncommenting the FFLAGS_HDF5 definition appropriate to your compiler
- uncommenting the LDFLAGS_HDF5 definition appropriate to your system

To call HTFRTC using NetCDF coefficient files through RTTOV requires that you compile against the NetCDF4 library (or you can use the ASCII coefficient files instead). To do this edit *build/Makefile.local* in a similar fashion as for HDF5 above:

- specify the path to your NetCDF build in NETCDF_PREFIX
- uncomment the FFLAGS_NETCDF definition appropriate to your compiler
- uncomment the LDFLAGS_NETCDF definition appropriate to your system

Then to compile RTTOV you can run the interactive script provided:
$ build/rttov_compile.sh

In order to use the RTTOV GUI and/or the RTTOV Python wrapper you must also have f2py installed on your system. The script detects the presence of f2py and provides the option of compiling the Python-related code.

More details including compatible compilers and information on compiling manually are given in the user guide.

Coefficient files and other ancillary data

The RTTOV package contains a commonly used subset of optical depth coefficient files. By default, coefficient files are found in the *rtcoef_rttov13/* directory. Coefficient files for all supported sensors are available from the website:
https://nwp-saf.eumetsat.int/site/software/rttov/download/coefficients/coefficient-download/

These include the optical depth coefficients for all supported sensors, the aerosol/cloud coefficient files for visible/IR scattering simulations, the hydrotable files for MW scattering simulations and the PC-RTTOV and HTFRTC coefficient files for PC simulations. The user guide provides more

information about the different types of coefficient files. It is not necessary to download all coefficient files: only those relevant to the simulations you are running are required.

Similarly, the land surface BRDF and emissivity atlas files are not included in the package due to their size. These can also be downloaded from the website:
https://nwp-saf.eumetsat.int/site/software/rttov/download/#Emissivity_BRDF_atlas_data

Verifying the build

RTTOV comes with a comprehensive test suite which is described in the user guide and more fully in the *rttov-test.pdf* document. The RTTOV test scripts and data are contained in the *rttov_test/* directory. You can run a basic test to check your installation as follows.

$ cd rttov_test
$ ./test_rttov13.sh ARCH=myarch BIN=myinstalldir/bin

You must provide the name of the compiler flag file you used when compiling RTTOV (e.g. *gfortran-openmp*). If you specified an installation directory when compiling RTTOV you must provide the location of the *bin/* directory created by the build. If you did not specify an installation directory the *bin/* directory is in your top-level RTTOV folder and you do not need to pass the *BIN=* argument to the test scripts.

This script runs several simulations using coefficient files which are provided in the package and checks the direct, tangent linear, adjoint and Jacobian model output against reference data. If the tests report OK, then RTTOV has compiled correctly. (You may see some very small differences to the reference data reported, particularly for the Jacobians: these are due to compiler-dependent differences and are not cause for concern).

Several other test scripts that run different kinds of simulations are included in the package. Some of these require additional files to be downloaded from the website. The user guide provides more details.

4. LICENCE

To use this software, users need to have registered for RTTOV with the NWP SAF (https://nwp-saf.eumetsat.int), and to have agreed to the terms of the RTTOV licence agreement.

5. PACKAGE CONTENTS

The contents of the package are as follows:

```
ReleaseNote.pdf
docs/
docs/doxygen_config_dev
docs/doxygen_config_user
docs/NWPSAFLogo_gradient_S.png
docs/NWPSAF_ReleaseNote_RTTOV13.0.pdf
docs/readme_rttov_make_scaercoef.txt
docs/rttov_doxygen_readme.dox
docs/rttov_gas_cloud_aerosol_units.pdf
docs/rttov_gui_v13.pdf
docs/rttov-quick-start.pdf
docs/rttov-test.pdf
docs/rttov-wrapper.pdf
docs/users_guide_rttov13_v0.1.pdf
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build/arch/cray-ecmwf
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gui/rview/surfedit.py
gui/rview/util.py
gui/rview/wxmpl.py
gui/test/
gui/test/__init__.py
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src/main/rttov_init_trans_scatt_ir.F90
src/main/rttov_intavg_chan_ad.F90
src/main/rttov_intavg_chan.F90
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src/test/rttov_k_bf.F90
src/test/rttov_k_tl.F90
src/test/rttov_lun.F90
src/test/rttov_make_cld_profile_inc.F90
src/test/rttov_make_emisrefl_inc.F90
src/test/rttov_make_opt_param.F90
src/test/rttov_make_opt_param_inc.F90
src/test/rttov_make_pccomp_inc.F90
src/test/rttov_make_profile_inc.F90
src/test/rttov_make_radiance_inc.F90
src/test/rttov_make_reflectivity_inc.F90
src/test/rttov_scale_cld_profile_inc.F90
src/test/rttov_scale_opt_param_inc.F90
src/test/rttov_scale_pccomp_inc.F90
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src/test/rttov_scale_reflectivity_inc.F90
src/test/rttov_taylor_test.F90
src/test/rttov_test.F90
src/test/rttov_test_k_mod.F90
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src/wrapper/rttov_c_interface.h
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src/wrapper/rttov_wrapper_transfer.F90
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wrapper/example_data_cpp.h
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wrapper/example_data_opt_param.py
wrapper/example_data.py
wrapper/example_data_rttovscatt_cpp.h
wrapper/example_data_rttovscatt.h
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src/gui/rttov_gui_f2py.F90
src/gui/rttov_gui_handle.F90
src/gui/rttov_gui_test_run.F90
src/hdf/
src/hdf/rttov_hdf_chanprof_io.F90
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src/main/rttov_alloc_ad.F90
src/main/rttov_alloc_aux_prof_coef.F90
src/main/rttov_alloc_aux_prof.F90
src/main/rttov_alloc_auxrad_column.F90
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src/main/rttov_alloc_prof.F90
src/main/rttov_alloc_profiles_dom.F90
src/main/rttov_alloc_prof_internal.F90
```

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wrapper/example_data_rttovscatt.py
wrapper/interface_example_c.c
wrapper/interface_example_cpp.cpp
wrapper/interface_example_python.py
wrapper/interface_example_rttovscatt_cpp.cpp
wrapper/interface_example_rttovscatt_python.py
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wrapper/Profile.h
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wrapper/ProfileScatt.h
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wrapper/Profiles.h
wrapper/ProfilesScatt.cpp
wrapper/ProfilesScatt.h
wrapper/pyrttov/
wrapper/pyrttov/decorator.py
wrapper/pyrttov/descriptor.py
wrapper/pyrttov_doc/
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wrapper/pyrttov_doc/conf.py
wrapper/pyrttov_doc/index.rst
wrapper/pyrttov_doc/library/
wrapper/pyrttov_doc/library/decorator.rst
wrapper/pyrttov_doc/library/descriptor.rst
wrapper/pyrttov_doc/library/index.rst
wrapper/pyrttov_doc/library/option.rst
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wrapper/pyrttov_doc/library/profilescatt.rst
wrapper/pyrttov_doc/library/pyrttov_public.rst
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wrapper/pyrttov_doc/library/rttype.rst
wrapper/pyrttov_doc/Makefile
wrapper/pyrttov_doc/pyrttov
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wrapper/pyrttov_example.py
wrapper/pyrttov/__init__.py
wrapper/pyrttov/option.py
wrapper/pyrttov/profile.py
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wrapper/pyrttov_rttovscatt_example.py
wrapper/pyrttov_rttovscatt_radar_example.py
wrapper/pyrttov/rttype.py
wrapper/pyrttov_visirscatt_example.py
wrapper/rttov_cc_interface.h
wrapper/rttov_c_interface.h
wrapper/Rttov_common.h
wrapper/Rttov.cpp
wrapper/Rttov_example.cpp
wrapper/Rttov.h
wrapper/RttovSafe.cpp
wrapper/RttovSafe_example.cpp
wrapper/RttovSafe.h
wrapper/RttovSafe_visirscatt_example.cpp
wrapper/RttovScatt.cpp
wrapper/RttovScatt_example.cpp
wrapper/RttovScatt.h
wrapper/RttovScatt_radar_example.cpp
wrapper/RttovScattSafe.cpp
wrapper/RttovScattSafe_example.cpp
wrapper/RttovScattSafe.h
wrapper/RttovScattSafe_radar_example.cpp
wrapper/Rttov_visirscatt_example.cpp
wrapper/rttov_wrapper_f2py.so
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