RTTOV development status

Pascal Brunel[1], John Eyre[2], Alan Geer[3], Stephan Havemann[2], James Hocking[2], Cristina Lupu[3], Marco Matricardi[3], Peter Rayer[2], Pascale Roquet[1], David Rundle[2], Roger Saunders[2], Emma Turner[2], Jérôme Vidot[1]

[1]Météo-France, [2]Met Office, [3]ECMWF

ITSC-21, Darmstadt, 29 November – 5 December 2017

Contents:

RTTOV v12.1 – new features

RTTOV v12.2 – planned developments

NWP SAF website

NWP SAF Radiance Simulator

RTTOV technical sub-group

RTTOV v12.1 – released Feb 2017

Updated visible/IR optical depth coefficients
including optional variable SO_2.

Visible/IR optical depth coefficients

LBLRTM v12.2, AER v3.2, MT_CKD_2.5.2

Updated ECMWF 83 profile set:

- More fixed gas species included.
- Modified CO_2, CH_4 and N_2O profiles.
- Reference profiles are valid for present-day.
- Profile ranges cover 1970-202x.

***Black**: mean (reference) profile*
***Blue**: min/max envelopes*
***Dashed**: previous dataset (2008)*
***Solid**: new dataset (2016)*

Visible/IR optical depth coefficients

LBLRTM v12.2, AER v3.2, MT_CKD_2.5.2

Updated ECMWF 83 profile set:

- More fixed gas species included.
- Modified CO_2, CH_4 and N_2O profiles.
- Reference profiles are valid for present-day.
- Profile ranges cover 1970-202x.

Coefficients on 54 levels.

Also 101 levels for hi-res IR sounders.

Variable O_3+CO_2 coefficients available for all IR-only and visible+IR sensors (v8 and v9 predictors).

Visible/IR optical depth coefficients

LBLRTM v12.2, AER v3.2, MT_CKD_2.5.2

Updated ECMWF 83 profile set:

- More fixed gas species included.
- Modified CO_2, CH_4 and N_2O profiles.
- Reference profiles are valid for present-day.
- Profile ranges cover 1970-202x.

Coefficients on 54 levels.

Also 101 levels for hi-res IR sounders.

Variable O_3+CO_2 coefficients available for all IR-only and visible+IR sensors (v8 and v9 predictors).

Sensors recently added/updated:

- *NOAA-20 VIIRS*
- *GEO-KOMPSAT-2 AMI*
- *GOES-16-19 ABI*
- *INSAT 3DR imager and sounder*
- *updated HIRS coefficients with shifted channels*
- *…*

Future plans:

- Evaluate impact of LBLRTM v12.8 and CLBLM for training coefficients
- Improve accuracy of SO_2 optical depth prediction

Microwave optical depth coefficients

Liebe-MPM 89/92 with O_2, N_2, WV, O_3

- O_2 line parameters from Tretyakov et al. 2005
- H_2O half-width of 183GHz line and its temperature dependency from Payne et al. 2008

ECMWF 83 profile set, coefficients on 54 levels.

Updated Zeeman SSMI/S coefficients on 84 levels:

- New LBL calculations for SSMI/S Zeeman channels using AMSUTRAN's new Zeeman capability.
- Smoother pressure grid.

Microwave optical depth coefficients

Liebe-MPM 89/92 with O_2, N_2, WV, O_3

- O_2 line parameters from Tretyakov et al. 2005
- H_2O half-width of 183GHz line and its temperature dependency from Payne et al. 2008

ECMWF 83 profile set, coefficients on 54 levels.

Updated Zeeman SSMI/S coefficients on 84 levels:

- New LBL calculations for SSMI/S Zeeman channels using AMSUTRAN's new Zeeman capability.
- Smoother pressure grid.

New files available on website with band-correction coefficients: these will become the default. Only affects radiances (not BTs).

Sensors recently added:

- *ORS COWVR*
- *SMOS MIRAS*
- *Nimbus-6 SCAMS*

Future plans:

- Improve spectroscopy above 200GHz (for MetopSG ICI).
- Test impact of non-uniform spectral response functions.
- Test impact of Planck-weighted coefficients.

RTTOV v12.1 – released Feb 2017

Updated visible/IR optical depth coefficients including optional variable SO_2.

New visible/IR scattering solver.

New visible/IR ice cloud optical properties.

Optionally supply cloud/aerosol concentrations in kg/kg for visible/IR simulations.

Visible/IR scattering solver

Discrete Ordinates solver for aerosol and cloud simulations.

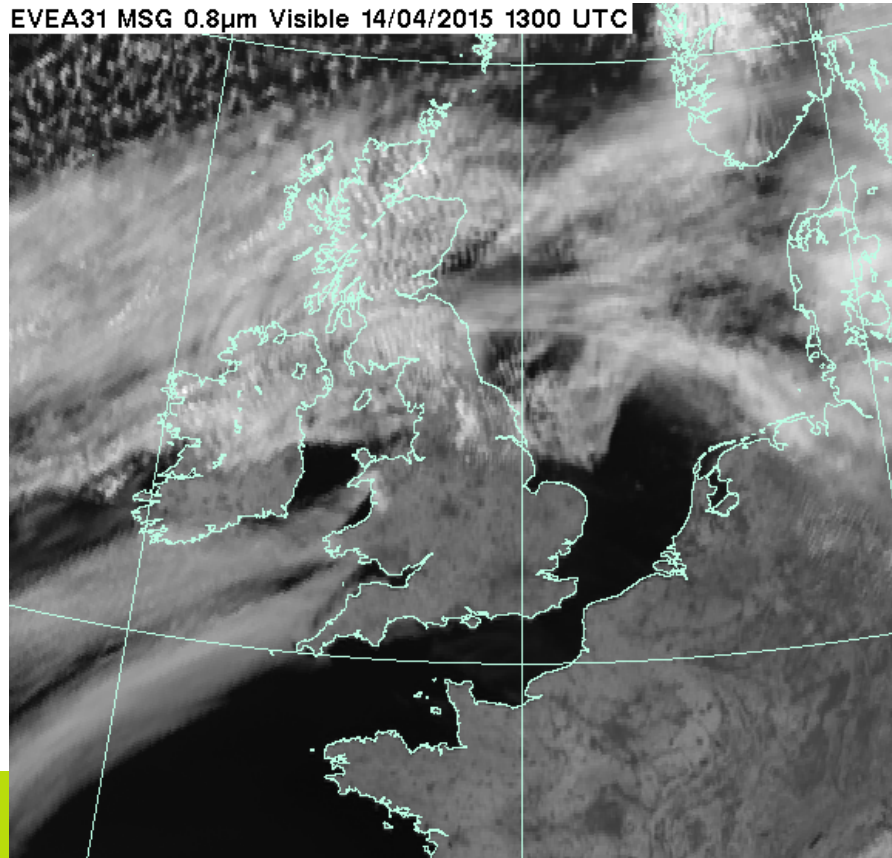
Solvers can be selected independently for thermal emission and solar radiation.

Essentially reproduces DISORT radiances for equivalent calls, but can be many times faster than DISORT, especially for clouds.

Direct, TL, AD and K models.

The SSEC (Baum *et al* 2011) ice optical properties replace the old Hex/Agg shapes.

The Baran ice parameterisation has been extended to the visible.



RTTOV v12.1 – released Feb 2017

Updated visible/IR optical depth coefficients including optional variable SO_2.

New visible/IR scattering solver.

New visible/IR ice cloud optical properties.

Optionally supply cloud/aerosol concentrations in kg/kg for visible/IR simulations.

Emissivity/BRDF atlas updates:

- New CAMEL IR emissivity atlas (Eva Borbas, 10p.02).
- Updated TELSEM2 and CNRM MW atlases.
- New more flexible interface to atlases.

New IR sea surface emissivity model including Tskin dependency.

New MW sea surface emissivity model TESSEM2 intended for use with MetopSG ICI.

RTTOV v12.1 – released Feb 2017

Updated visible/IR optical depth coefficients including optional variable SO_2.

New visible/IR scattering solver.

New visible/IR ice cloud optical properties.

Optionally supply cloud/aerosol concentrations in kg/kg for visible/IR simulations.

Emissivity/BRDF atlas updates:

- New CAMEL IR emissivity atlas (Eva Borbas, 10p.02).
- Updated TELSEM2 and CNRM MW atlases.
- New more flexible interface to atlases.

New IR sea surface emissivity model including Tskin dependency.

New MW sea surface emissivity model TESSEM2 intended for use with MetopSG ICI.

Updated non-LTE model and new PC-RTTOV coefficients allowing non-LTE optionally (Marco Matricardi, 1p.04).

RTTOV v12.1 – released Feb 2017

Updated visible/IR optical depth coefficients including optional variable SO_2.

New visible/IR scattering solver.

New visible/IR ice cloud optical properties.

Optionally supply cloud/aerosol concentrations in kg/kg for visible/IR simulations.

Emissivity/BRDF atlas updates:

- New CAMEL IR emissivity atlas (Eva Borbas, 10p.02).
- Updated TELSEM2 and CNRM MW atlases.
- New more flexible interface to atlases.

New IR sea surface emissivity model including Tskin dependency.

New MW sea surface emissivity model TESSEM2 intended for use with MetopSG ICI.

Updated non-LTE model and new PC-RTTOV coefficients allowing non-LTE optionally (Marco Matricardi, 1p.04).

Interface to the HT-FRTC PC-based fast RT model (Stephan Havemann, 2p.01).

RTTOV v12.1 – released Feb 2017

Updated visible/IR optical depth coefficients including optional variable SO_2.

New visible/IR scattering solver.

New visible/IR ice cloud optical properties.

Optionally supply cloud/aerosol concentrations in kg/kg for visible/IR simulations.

Emissivity/BRDF atlas updates:

- New CAMEL IR emissivity atlas (Eva Borbas, 10p.02).
- Updated TELSEM2 and CNRM MW atlases.
- New more flexible interface to atlases.

New IR sea surface emissivity model including Tskin dependency.

New MW sea surface emissivity model TESSEM2 intended for use with MetopSG ICI.

Updated non-LTE model and new PC-RTTOV coefficients allowing non-LTE optionally (Marco Matricardi, 1p.04).

Interface to the HT-FRTC PC-based fast RT model (Stephan Havemann, 2p.01).

Python/C++ wrapper supports all direct and K model clear-sky and scattering simulations.

RTTOV GUI updates (Pascale Roquet, 1p.03).

RTTOV v12.2 – March 2018

MFASIS fast visible scattering parameterisation.

New cloud liquid water optical property parameterisation in terms of LWC and D*eff*.

MFASIS

Example MFASIS simulation taken from Scheck et al 2016

MFASIS is a look-up-table-based parameterisation of libRadtran/DISORT cloud scattering simulations.

Input variables: *vertically integrated cloud liquid and ice water optical depths and effective radii, surface albedo, satellite and solar zenith angles, and the scattering angle.*

TOA reflectance represented by the first terms of a 2D Fourier series as a function of the zenith angles.

MFASIS is ~4 orders of magnitude faster than DISORT with 16 streams.

RTTOV v12.2 will also include alternative Mie optical properties for water cloud based on liquid water content and cloud droplet effective diameter.

Much of this work is being undertaken by DWD who recently joined the NWP SAF consortium.

Scheck, L., P. Frèrebeau, R. Buras-Schnell, B. Mayer, 2016: A fast radiative transfer method for the simulation of visible satellite imagery. JSQRT, 175, 54-67.

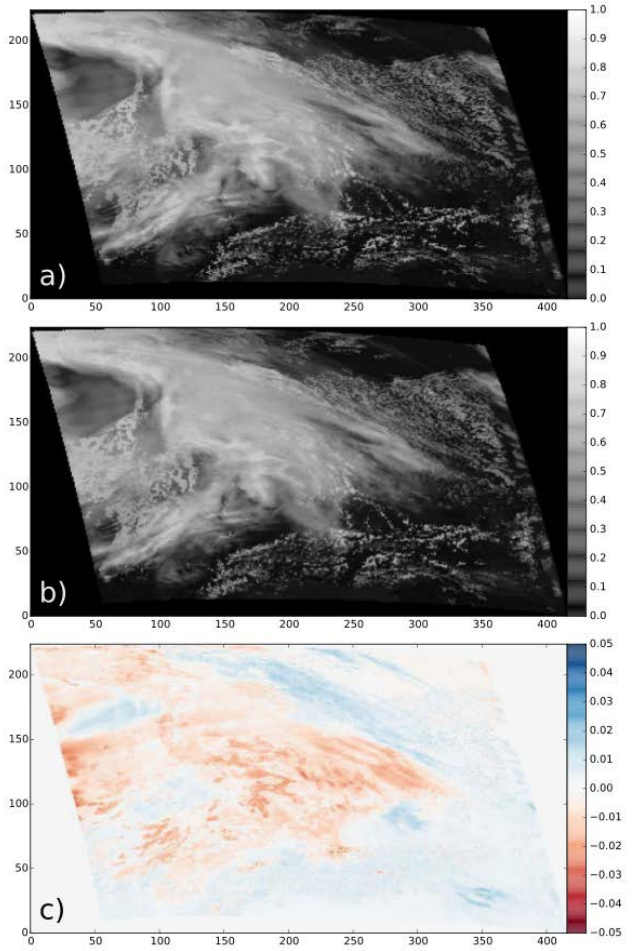


Figure 6: Synthetic 0.6μm SEVIRI images of the COSMO-DE domain generated by a) DISORT and b) MFASIS, and c) the difference MFASIS-DISORT for 12 UTC on June 15th, 2012.

RTTOV v12.2 – March 2018

MFASIS fast visible/near-IR scattering parameterisation.

New cloud liquid water optical property parameterisation in terms of LWC and D*eff*.

Explicit visible/IR cloud/aerosol optical properties active in TL/AD/K.

New option for sea surface solar BRDF model with reduced bias.

RTTOV v12.2 – March 2018

MFASIS fast visible/near-IR scattering parameterisation.

New cloud liquid water optical property parameterisation in terms of LWC and D*eff*.

Explicit visible/IR cloud/aerosol optical properties active in TL/AD/K.

New option for sea surface solar BRDF model with reduced bias.

RTTOV-SCATT updates to enable ICI simulations.

Updates to RTTOV-SCATT optical properties.

New OpenMP interfaces for RTTOV-SCATT.

RTTOV v12.2 – March 2018

MFASIS fast visible/near-IR scattering parameterisation.

New cloud liquid water optical property parameterisation in terms of LWC and D*eff*.

Explicit visible/IR cloud/aerosol optical properties active in TL/AD/K.

New option for sea surface solar BRDF model with reduced bias.

RTTOV-SCATT updates to enable ICI simulations.

Updates to RTTOV-SCATT optical properties.

New OpenMP interfaces for RTTOV-SCATT.

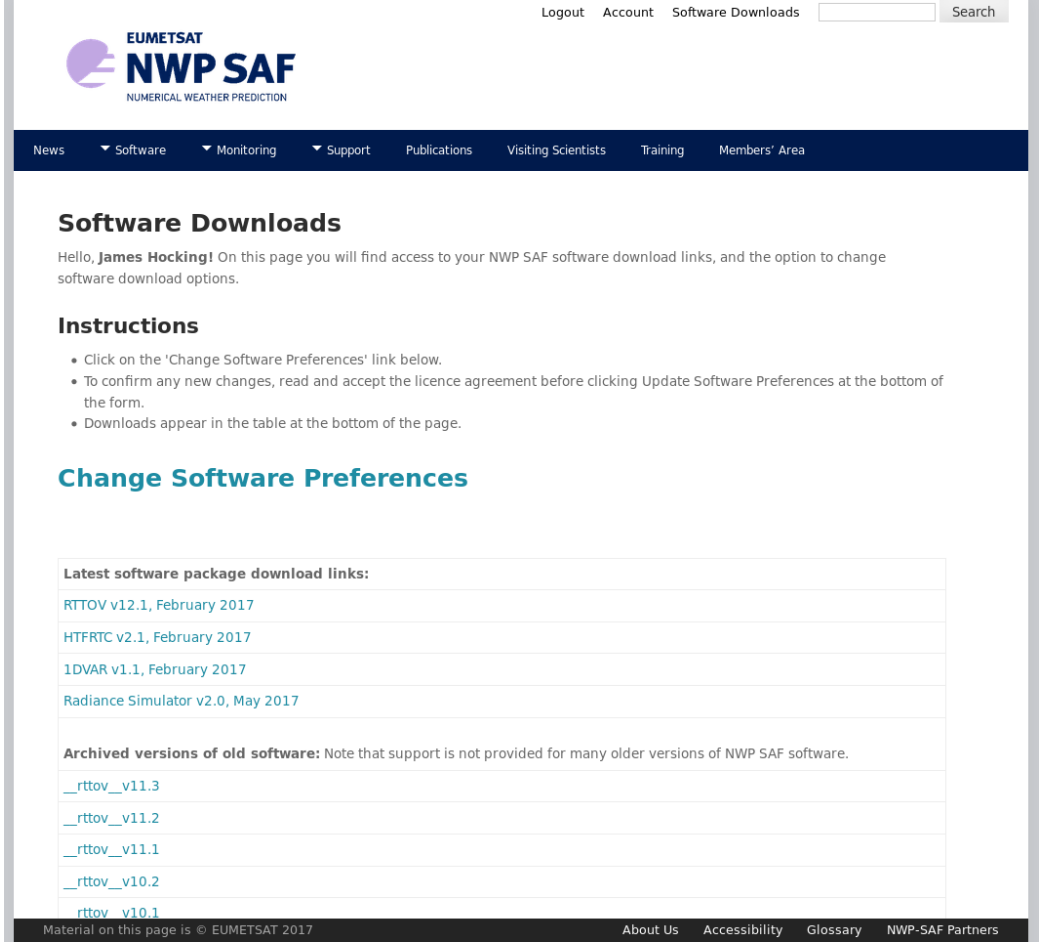
Updates to HT-FRTC interface.

Support for MTG-IRS lightly-apodised radiances via PC-RTTOV and HT-FRTC.

NWP SAF web site

Register once, download any NWP SAF product including archived versions.

https://www.nwpsaf.eu/



Met Office

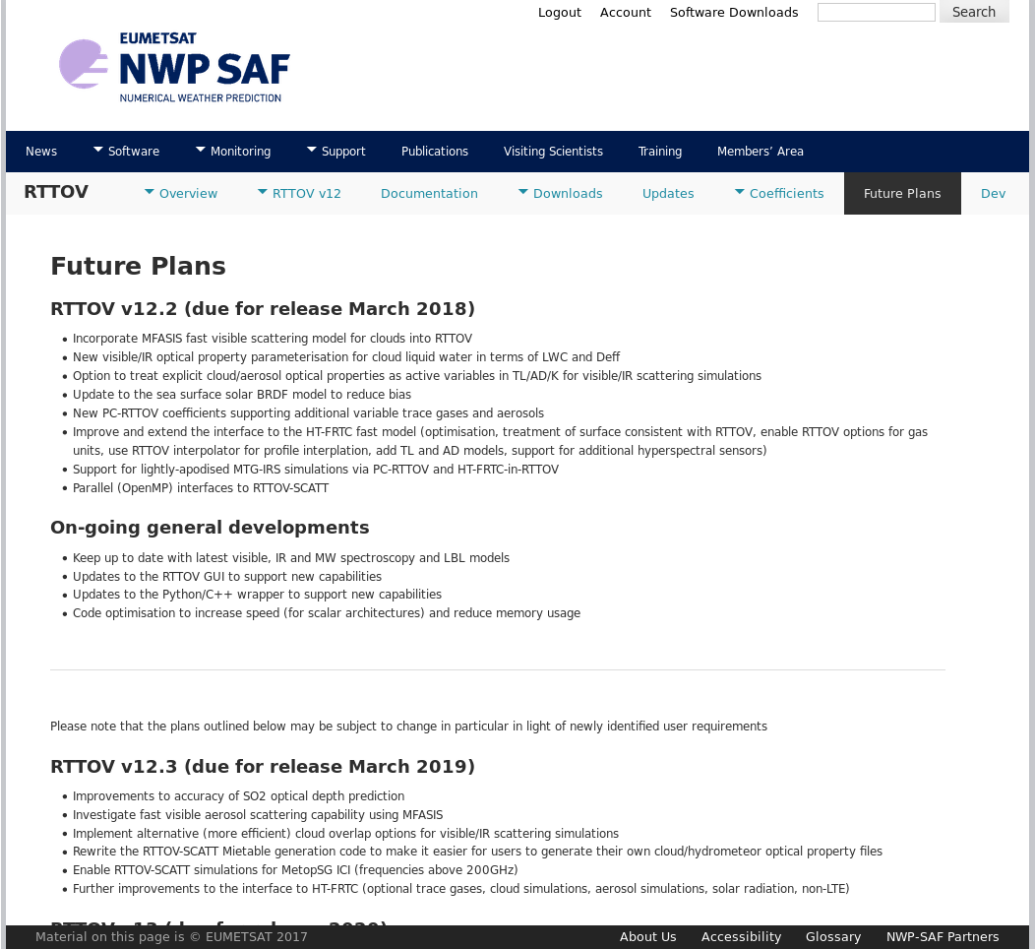
NWP SAF web site

Register once, download any NWP SAF product including archived versions.

Future plans and user survey.

https://www.nwpsaf.eu/site/software/rttov/future-plans/

https://www.surveymonkey.co.uk/r/7BL2YPN



NWP SAF Radiance Simulator

RadSim is essentially a wrapper for RTTOV.

Generates simulated observations. Currently supports atmospheric profile data from:

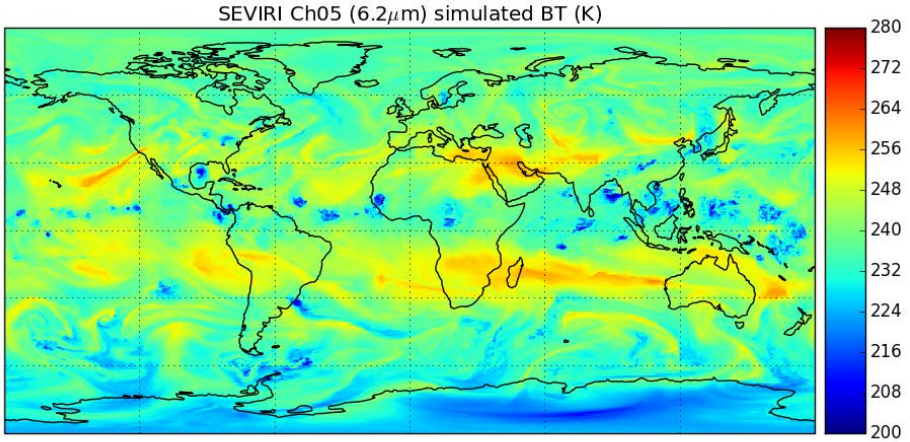
- *Met Office UM PP files*
- *ECMWF GRIB files*
- *NWP SAF profile datasets (available on the NWP SAF website)*

Supports IR and MW clear-sky and cloudy simulations and use of emissivity atlases.

Simulations run on given NWP model grid or for a user-specified list of latitudes/longitudes.

Next minor release due Q2 2018:

- Updated for RTTOV v12.2
- Variable ozone enabled for all data sources
- Enable use of RTTOV parallel interfaces
- More RTTOV options available



RTTOV technical sub-group
17:30 Thursday

Talk about some of the recent and planned developments in greater detail.

Come and ask questions about RTTOV (and the Radiance Simulator).

Feedback welcome including requests for new/updated capabilities.

Thanks for your attention