



RTTOV development status

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Outline

- New optical depth parameterisation/coefficient updates
- Rayleigh scattering
- VIS/IR cloud scattering
- RTTOV-SCATT
- Other updates
- Radiance Simulator v3.0

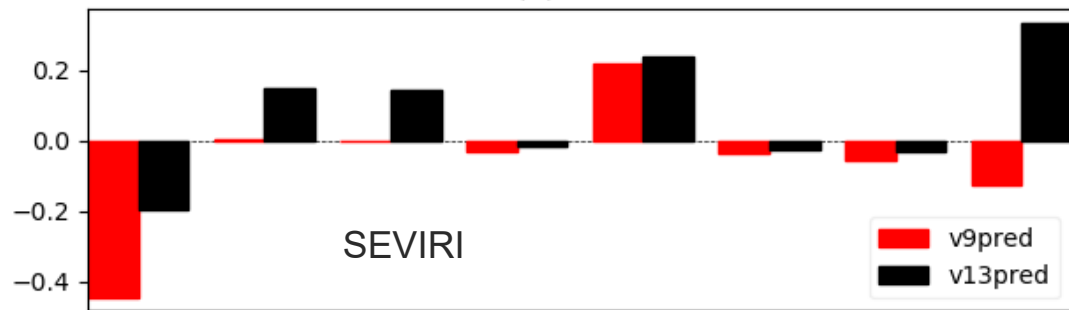
Optical depth coefficients

- VIS/IR coefficients updated to [LBLRTM v12.8](#).
- [All-trace-gas](#) coefficients (including variable SO_2) available for [non-hi-res](#) sensors.
- New [optical depth parameterisation](#). One set of predictors supporting:
 - [solar](#) radiation
 - [zenith angles up to 85°](#) (GEO sensors)
 - [all combinations](#) of optional [variable gases](#)

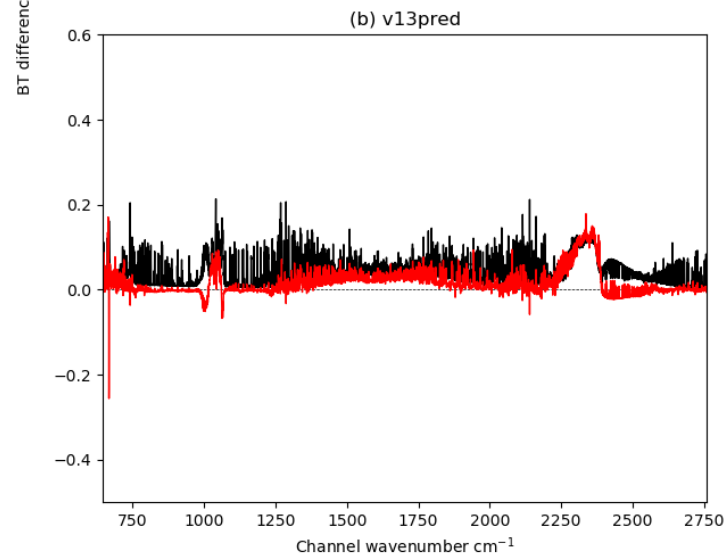
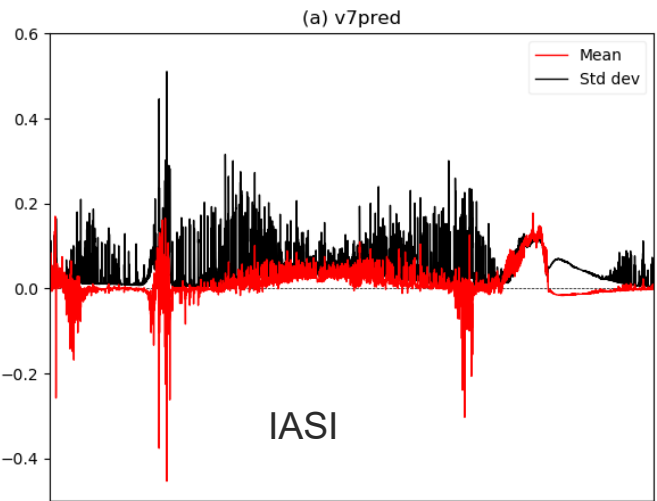
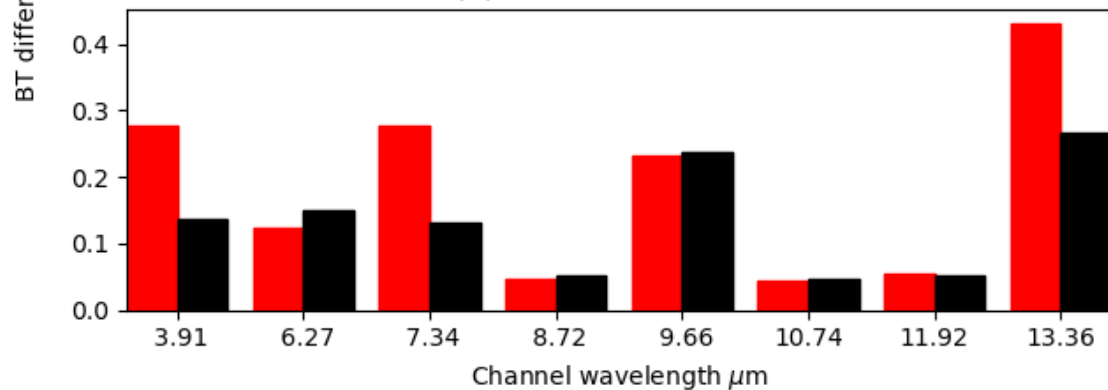


Comparisons to LBLRTM radiances for 5000 independent profiles with varying water vapour and ozone.

(a) Mean



(b) Standard deviation



Rayleigh scattering

- Rayleigh extinction for v9 predictors is included in LBLRTM simulations and is therefore “baked” into the optical depth coefficients.
- Rayleigh extinction for v13 predictors is computed within RTTOV.
- Rayleigh scattering can therefore be excluded entirely from simulations if required.
- Also enables option for Rayleigh multiple scattering in visible cloud/aerosol simulations using the DOM solver.
=> *Very slow, but also allows clear-sky Rayleigh multiple scattering.*

VIS/IR scattering

- Updated **refractive index** dataset for **CLW** optical properties.
- **Parameterisation** of **CLW effective diameter**.
- **Cloud transmittances** are a new **output** from cloudy simulations.
- *grid_box_avg_cloud* option **true** by default.
- **MFASIS** fast visible cloud parameterisation:
 - now trained using **DOM Rayleigh** multiple scattering
 - improved **flagging** of potentially **problematic cases**
 - code **optimisation** resulting in significant speed-ups (**2-4x for direct** model).

Plots from Christina Stumpf

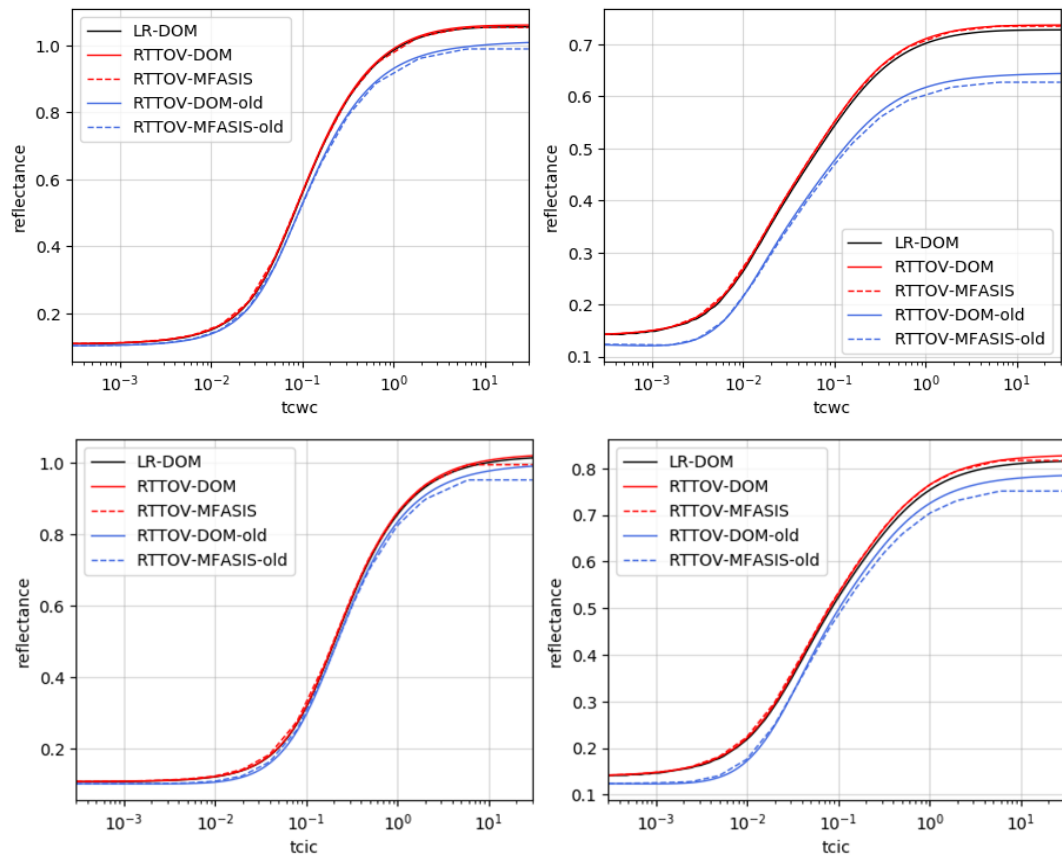
SEVIRI 0.6um channel

Comparing libRadtran+DISORT (LR-DOM), RTTOV-DOM (v13), RTTOV-MFASIS (v13) and the “old” (i.e. v12) models.

Top panel: varying water cloud optical depth.

Bottom panel: varying ice cloud optical depth.

Left panel/right panel represent two different viewing/solar geometries.



RTTOV-SCATT updates

- Old RTTOV-SCATT interface had **hard-coded hydrometeors**: rain, cloud liquid, snow and cloud ice (and “totalice”). Each had their own named array in the input cloud profile structure.
- **New interface** allows for an **arbitrary** number of **hydrometeors**, determined by the “**hydrotable**” optical property files (replace old Mietable files).
- Can also optionally specify **per hydrometeor cloud fractions**, instead of a single cloud fraction for all hydrometeors in a level.

RTTOV-SCATT updates

- New **hydrotables** are available tuned for the IFS with 5 hydrometeors: rain, snow, graupel, cloud liquid and cloud ice.
- New **options** available for **hydrotable generation**.
- **Users** are **encouraged** to make their own **custom hydrotables** for particle types consistent with NWP model assumptions.
- **Option** exists to include **per-channel optical properties** (usually RTTOV-SCATT uses the same properties for V-/H-pol channels) e.g. to explore **oriented particle** models.

RTTOV-SCATT updates

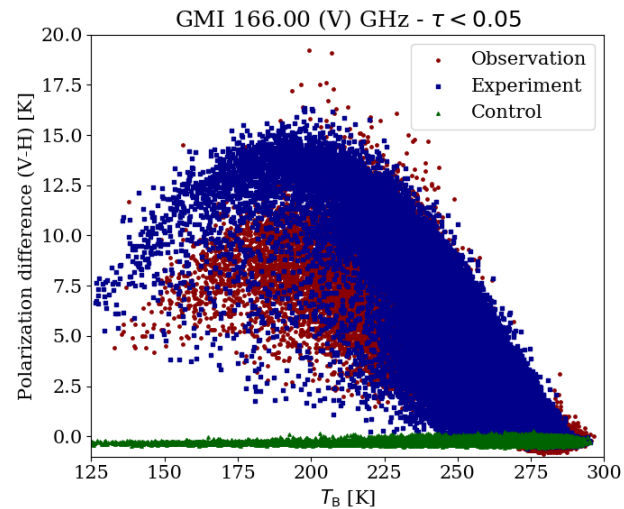
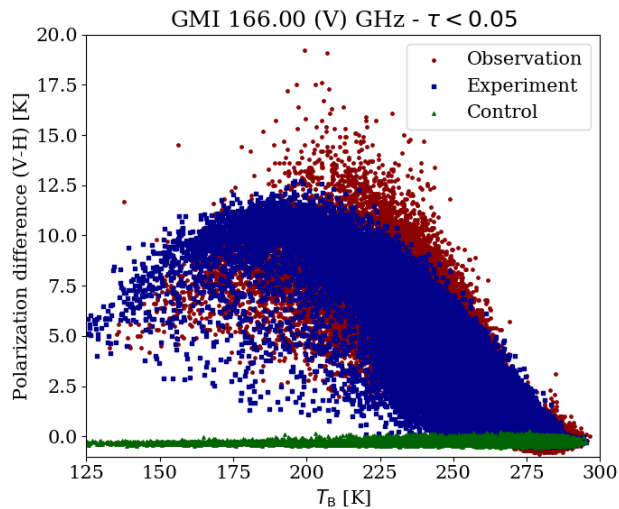
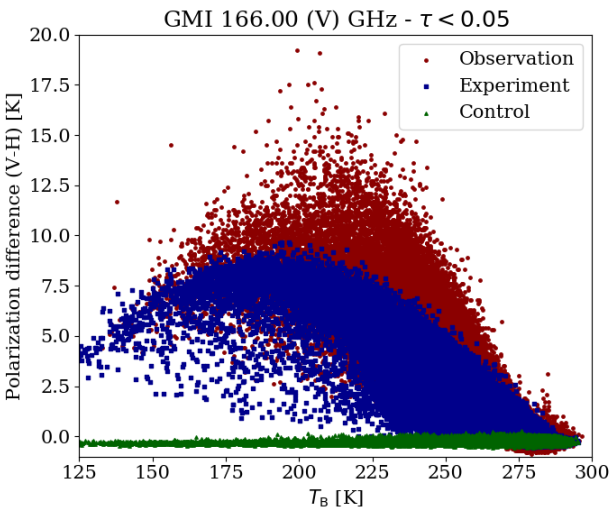
Vasileios Barlakas (Chalmers) and Alan Geer

$$AR = \text{extinction } h / \text{extinction } v = \text{extinction } v/h * (1+x) / \text{extinction } v/h * (1-x)$$

AR=1.22 (x=10%)

AR=1.3 (x=13%)

AR=1.4 (x=17%)

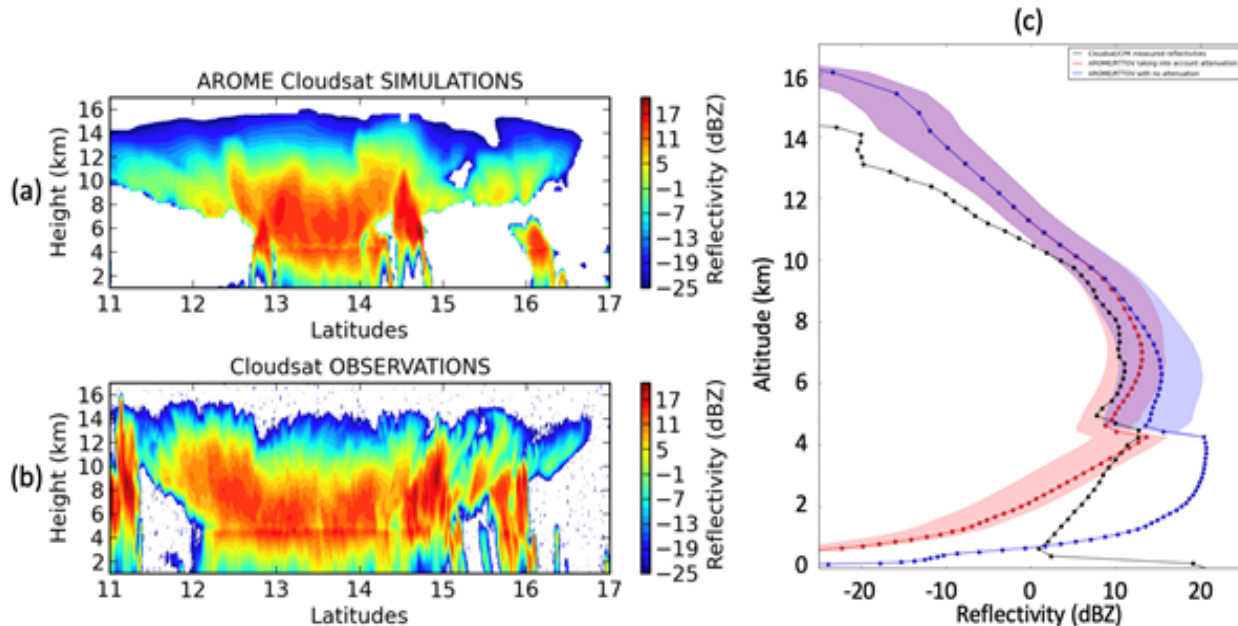


RTTOV-SCATT – active sensors

Developed by [Philippe Chambon](#) with [Alan Geer](#).

Currently supports [CloudSat CPR](#) and [GPM DPR](#).

Activate by supplying [additional argument](#) to RTTOV-SCATT which contains the [simulated reflectivities](#).



- a) RTTOV-SCATT simulated CPR reflectivities using AROME forecast
- b) CPR observations
- c) One profile: observed (black), simulated reflectivity (blue), and simulated attenuated reflectivity (red). Shaded areas represent spread of simulations with different particle shapes from Liu database available in hydrotale generation.

Other updates

- Various **options** have **changed defaults** to recommended/common values (documented in user guide).
- **MW CLW absorption** calculation *always* done on **input levels** (not coef levels).
- **RTTOV-SCATT** calculations *always* done in **radiance** (not BT).
- **Downwelling** “secondary” **radiances** now contain the **CMBR** contribution.
- Update to support **polarisation** for **TROPICS** sensor.
- **Specularity** parameter is now **per-channel** (rather than per-profile).
- Optional **output** of **emissivity atlas PC scores** and **eigenvectors** for the UWIRemis and CAMEL 2007 IR atlases.
- **Output** of **geometric heights** of pressure levels.

Radiance Simulator v3.0

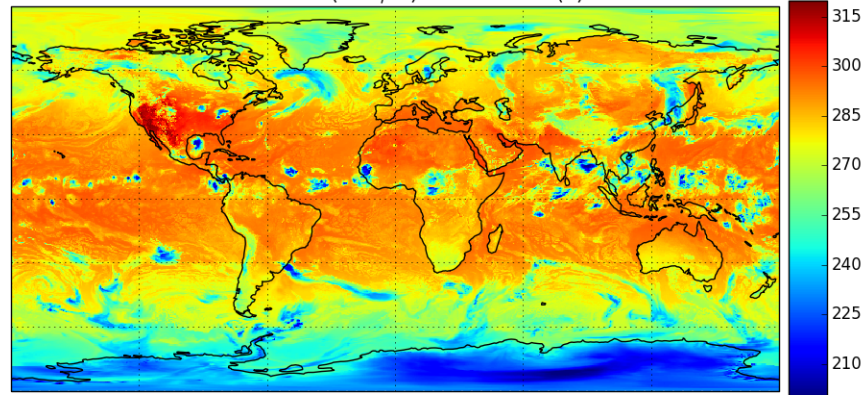
RadSim is essentially a [wrapper](#) for RTTOV.

Generates [simulated observations](#). Currently supports atmospheric profile data from:

- *Met Office UM PP and fieldfiles*
- *ECMWF GRIB and netCDF files*
- *ICON GRIB files*
- **HARMONIE GRIB files**
- **JMA GRIB files**
- *NWP SAF profile datasets*

Simulations run on given [NWP model grid](#) or for a [user-specified list of latitudes/longitudes](#) (optionally including [temporal interpolation](#) of model fields).

SEVIRI Ch09 (10.8 μ m) simulated BT (K)



Option to simulate [satellite footprints](#) modelled as [ellipses](#) centred on each observation.

Python script for generating [observation data files](#) for [GEO sensors](#).

Supports [most types](#) of RTTOV simulation, and most [RTTOV options](#) can be configured.

Option to supply [scaled CO₂ background profile](#) for older sensors.

Additional optional outputs include [Jacobians](#), [CADS height assignments](#) and [transmittances](#).

Summary

- RTTOV v13.0 released November 2020.
- Updated optical depth parameterisation.
- Improved treatment of Rayleigh scattering.
- Improvements to VIS/IR and MW scattering.
- RadSim v3.0 released June 2021, based on RTTOV v13.
- Available from the NWP SAF website:

<https://nwp-saf.eumetsat.int/site/>

Thanks for your attention!