Met Office

RTTOV development status

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ITSC-22, Saint-Sauveur, 31 October 2019

Met Office METEO FRANCE ECMWF DWD EUMETSAT NWP SAF NUMERICAL WEATHER PREDICTION

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Overview

RTTOV v12.2 released April 2018 / RTTOV v12.3 released March 2019

- Extension to far-IR
- New coefficients
- Aerosol/cloud/hydrometeor scattering updates
- Surface-related updates
- Principal Components simulation updates

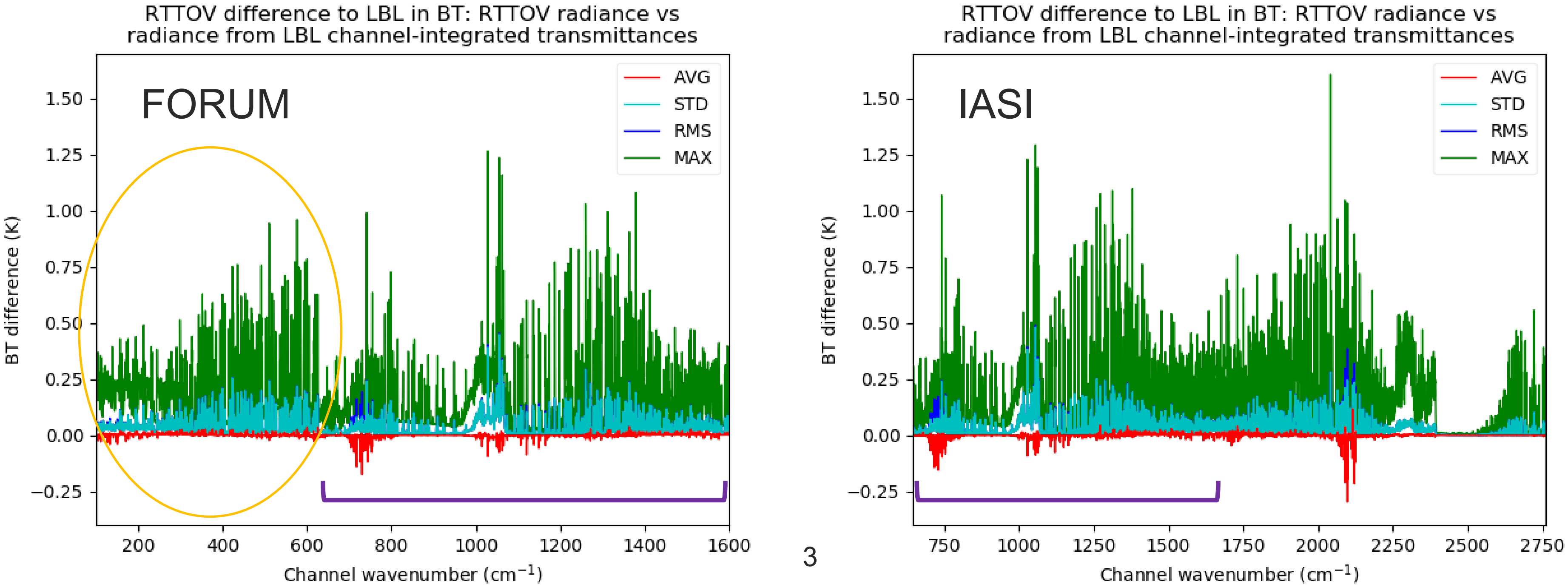
NWP SAF Radiance Simulator

Future plans

Extension to far-IR

In support of ESA FORUM mission (see J. Vidot 1p.13)

- Line-by-line transmittance database up to 100 microns
- Sea surface emissivity
- Cloud optical properties (Baran2018 ice parameterisation)



New optical depth coefficients

Microwave coefficients using measured SRFs (see D. Duncan 2p.09)

Older sensors for C3S (see J. Vidot 6p.04)

- Nimbus platforms: IRIS, MRIR, HRIR, SIRS

Other new sensors supported:

- HY-2 MWRI, FY-3C VIRR, FY-3D MERSI-2, FY-4A AGRI
- Sentinel3 SLSTR-B, Metop-C AVHRR, Meteor-M N2 MSU-MR

Visible/IR scattering – clouds

MFASIS fast visible cloud parameterisation – see C. Stumpf 11p.03

Cloud liquid water properties in terms of particle size:

- follows Mie properties implemented in libRadtran
- user must provide effective diameter (next version of RTTOV will include a parameterisation of CLW D_{eff})

Baran2018 ice optical properties:

- Improved spectral consistency
- Extended to far-IR

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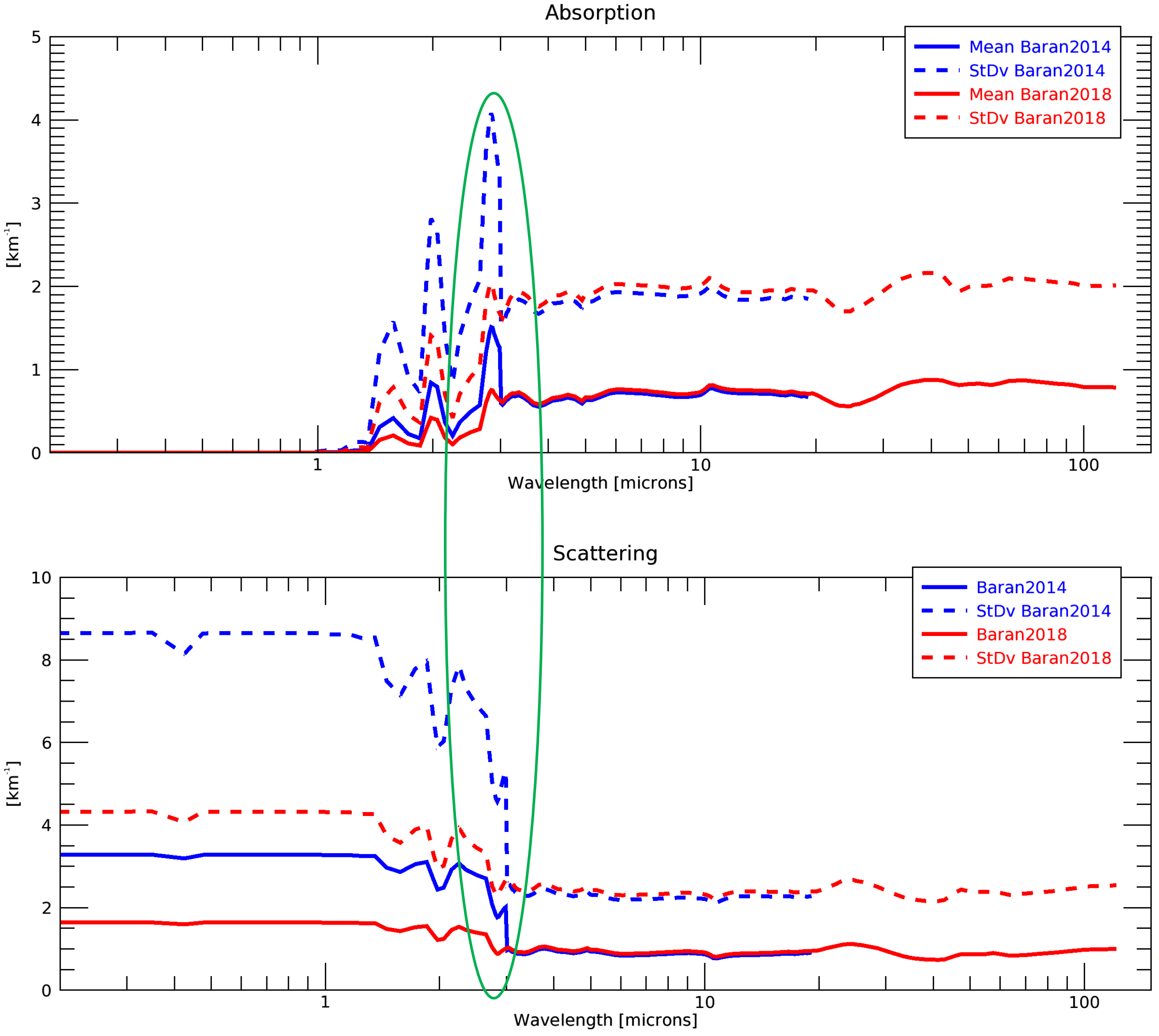
Based on a mass-dimension relationship: $m=aD^2$

For Baran2014
VIS/NIR: a=0.0257
IR: a=0.0257 « weighted »
=> Spectrally inconsistent with a gap at 3 microns

For Baran2018
VIS to FIR: a=0.05
=> Spectrally consistent



Visible/IR scattering – aerosols

New aerosol optical property files containing 9 CAMS components:

- Black carbon, dust (3 size bins), sulphates, sea salt (3 size bins), organic matter

Tool to generate custom aerosol optical property files for use with RTTOV:

- stand-alone executable driven by an ASCII configuration file
- refractive index and size distribution data provided via additional simple ASCII files
- allows for hydrophilic species defined for user-specified relative humidity values

Currently all aerosols use Mie optical properties.

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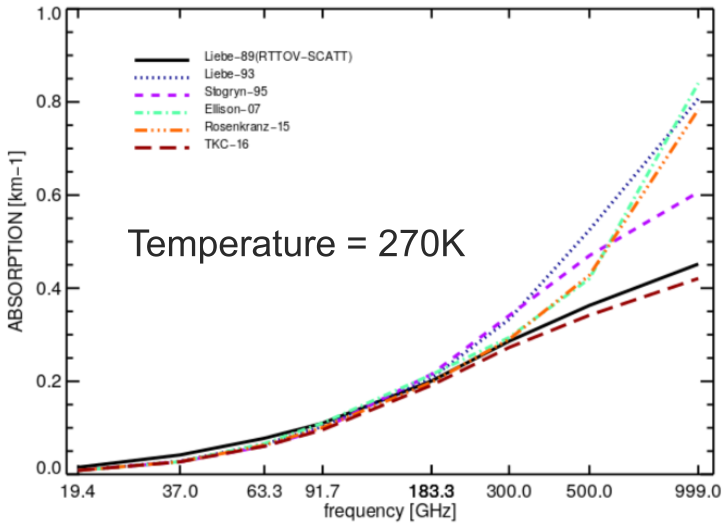
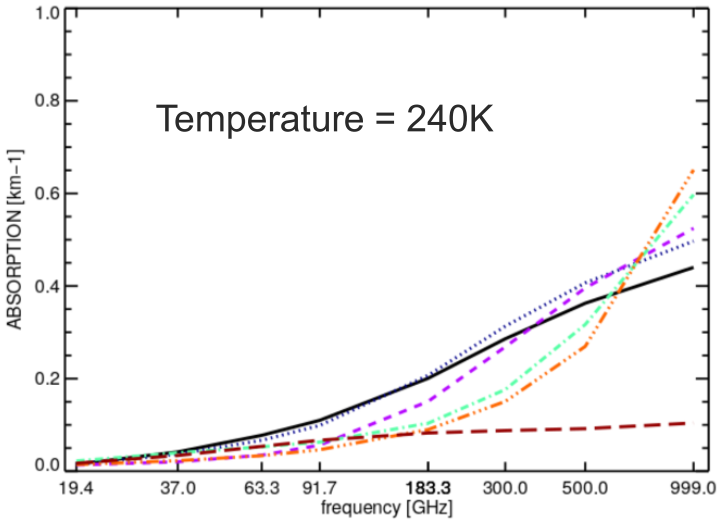
MW scattering

New liquid water permittivity parameterisations:

- Liebe (1989) – existing parameterisation
- Rosenkranz (2015) – recommended, applicable for ICI
- Turner, Kneifel, Cadeddu “TKC” (2016)

The newer parameterisations give better fits to obs for super-cooled water (Lonitz and Geer, 2018 – see 5p.07).





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MW scattering

New liquid water permittivity parameterisations:

- Optical property files updated using Rosenkranz 2015 for CLW and rain
- These are also available as options in RTTOV for CLW absorption

ARTS optical property database for non-spherical particles

=> in particular, applicable for ICI

New optional outputs to enable all-sky emissivity retrievals (Baordo and Geer, 2016).

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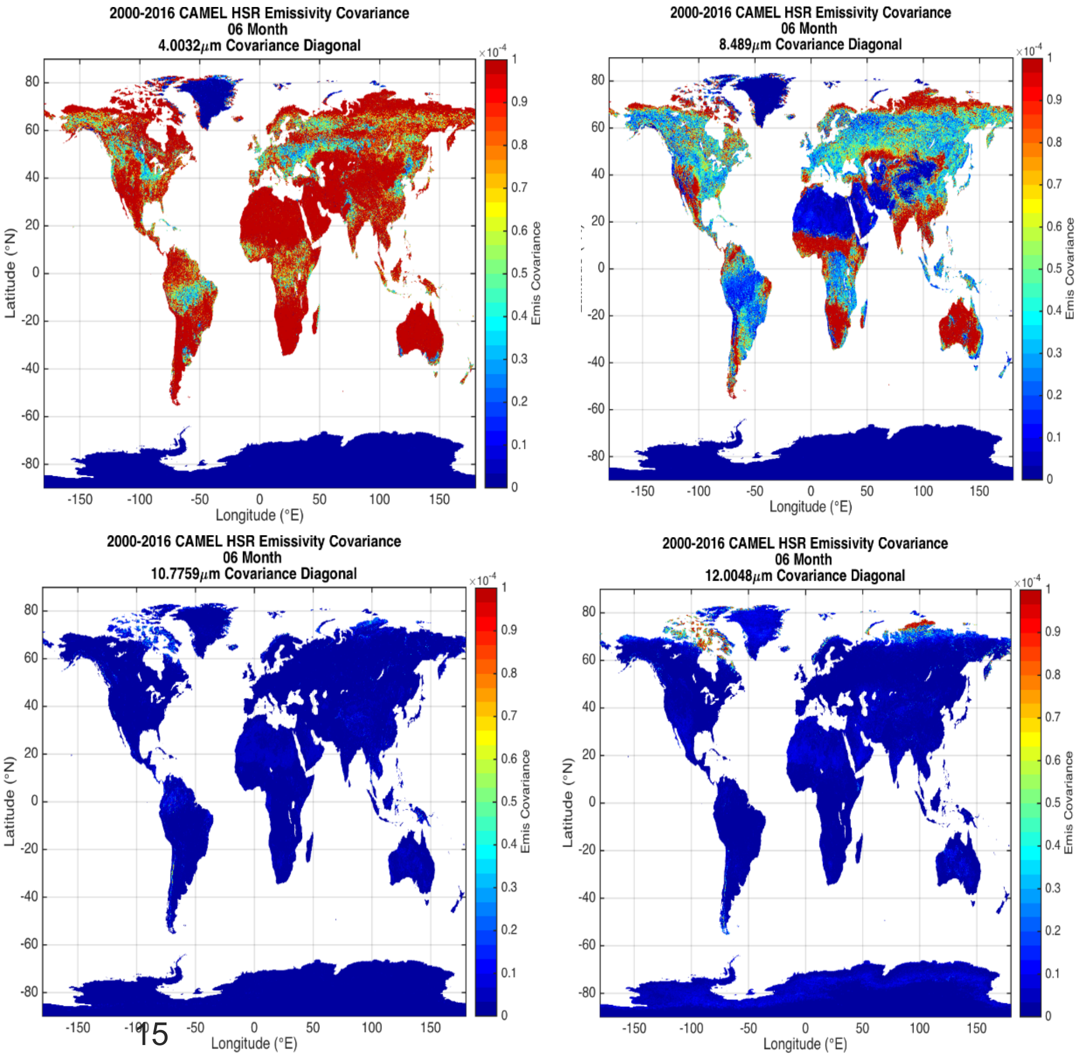
CAMEL climatology IR emissivity atlas

Original CAMEL atlas is based on 2007 “golden year”. New atlas is based on multi-year climatology (2000-2016).

Includes new standard deviation dataset at 0.25°x0.25°
(cf UWIRemis stdv data at 0.5°x0.5°).

More sophisticated handling of snow: accounts for whether the atlas spectrum includes snow or not *vs* user input *snow_fraction* amount.



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PC-RTTOV updates

Supported sensors: IASI, AIRS, IASI-NG (CrIS coefficients in preparation).

Supports simulations over land/sea.

Optional non-LTE correction.

New capabilities:

- Additional optional trace gases: O_3, CO_2, CO, N_2O, CH_4
- Aerosol simulations using OPAC components.

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HTFRTC updates

Supported sensors: IASI, AIRS, IASI-NG, CrIS, MTG-IRS.

Supports simulations over land/sea.

New capabilities:

- Additional optional trace gases: O_3, CO_2, CO, N_2O, CH_4, SO_2
- Optional output of overcast radiances.
- Optional "simple" cloud (based on single CTP and cloud fraction).
- Improved integration with RTTOV (use of emissivity atlases, support for more RTTOV simulation options, multi-threaded simulations).

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Radiance Simulator

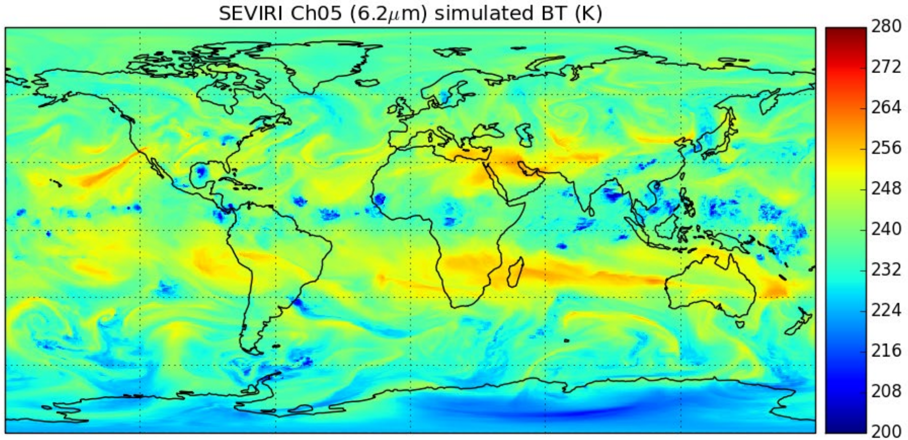
RadSim is essentially a wrapper for RTTOV.

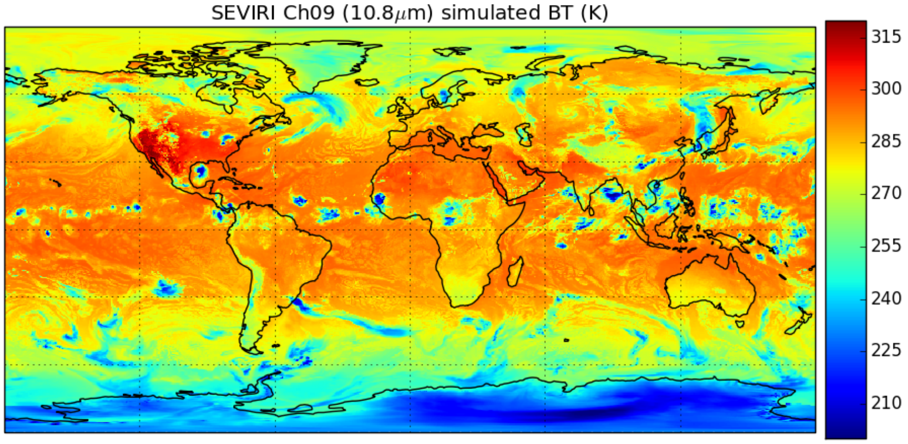
Generates simulated observations. Currently supports atmospheric profile data from:

- *Met Office UM PP and fieldsfiles*
- *ECMWF GRIB and netCDF files*
- *DWD ICON GRIB files*
- *NWP SAF profile datasets (available on the NWP SAF website)*

Supports most RTTOV simulation types, most RTTOV options, and use of emissivity/BRDF atlases.

Simulations run on given NWP model grid or for a user-specified list of latitudes/longitudes: model grids are spatially/temporally interpolated.





RTTOV v13 – due September 2020

New gas optical depth parameterisation:

- will make it easier to add new optional variable gases
- some indications of improved accuracy, for example in mid-tropospheric water vapour channels
- separable Rayleigh extinction

New outputs, for example:

- geopotential height of pressure levels
- VIS/IR cloud transmittances

VIS/IR scattering updates:

- parameterisation for cloud liquid water effective diameter
- improvements to MFASIS
- full Rayleigh multiple-scattering in DOM solver

MW scattering:

- flexible hydrometeors (enables arbitrary number of particle types)
- active sensor capability (see P. Chambon 1p.14)

Updates to Principal Components models

RTTOV technical sub-group
17:00 Saturday

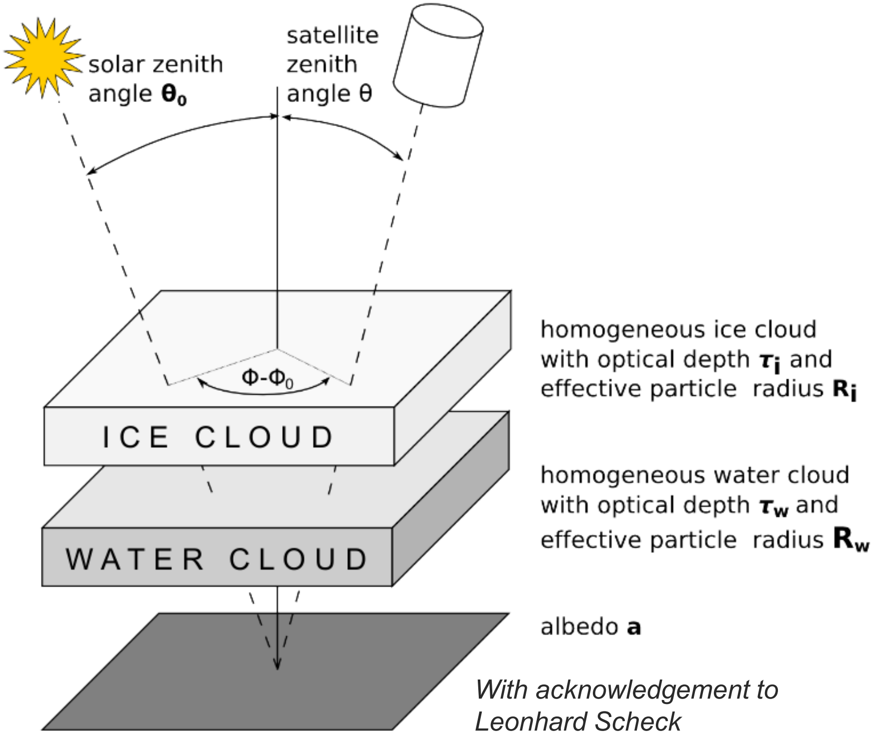
Talk about some planned future developments in greater detail.

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

Feedback welcome including requests for new/updated capabilities.

Thanks for your attention!

Visible scattering – MFASIS (see C. Stumpf 11p.03)



With acknowledgement to Leonhard Scheck

Look-up-table-based approach, parameterises DOM simulations of simplified cloud fields.

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

8 input variables: satellite and solar zenith angles, scattering angle, surface albedo, τ_w, R_w, τ_i, R_i

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

Has been modified to improve simulations for mixed-phase cloud and to account for variable water vapour.

Solar sea BRDF model

2D wave facet model from Yoshimori *et al* (1995)

Wave spectrum parameterisation:

- JONSWAP (Hasselmann *et al* 1973)
- Elfouhaily *et al* 1998 (new in v12.2)

Simulated minus observed ToA reflectance for cloud-cleared sun-glint affected SEVIRI pixels using JONSWAP model (top) and Elfouhaily *et al* (bottom).

Dark bias away from sun-glint mitigated by adding fixed ocean/fresh water reflectance spectra to model BRDF.