LMU LUDWIG-MAXIMILIANS-UNIVERSITÄT MÜNCHEN

FAKULTÄT FÜR PHYSIK

METEOROLOGIE

NILU

Generic Radiative Transfer Model for the Earth's Surface Atmosphere System: Towards a community tool

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Motivation

Radiative transfer modelling plays a key role for remote sensing because it is central for the development and testing of inversion algorithms as well as for the design of new remote sensing instruments. The libRadtran software package can be used to simulate the measurements of passive remote sensing instruments.

Within the ESA-project ESASLight the libRadtran package is improved and extended to provide all radiative transfer modelling capabilities required for Earth remote sensing applications in the spectral range from 280 nm to 100 µm.

http://www.meteo.physik.uni-muenchen.de/~esaslight2/

LibRadtran software package

- Flexible and comprehensive software package for radiative transfer
- Spectral resolutions: line-by-line, quasi-spectral, and correlated-k
- Output quantities: Radiance, irradiance, actinic flux, heating rate, brightness temperature
- Radiative transfer solvers: MYSTIC(Monte Carlo), (C)DISORT, twostream, ...
- (C)**DISORT** features:
  - Geometry: plane-parallel or pseudo-spherical
  - Raman scattering
  - Numerically stable version in C
- **MYSTIC** features:
  - Geometry: 3D plane-parallel, 1D spherical
  - Scalar and vector radiative transfer
  - Variance reduction methods for efficient RT calculations with highly peaked phase functions and with high spectral resolution
- Graphical User Interface (Prototype)
- More than 200 reviewed publications, which used libRadtran
- Freely available at www.libradtran.org (version without MYSTIC-3D)

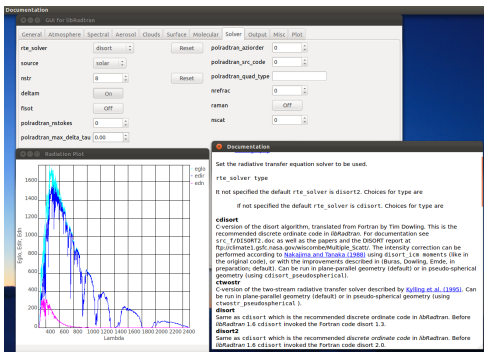
B. Mayer and A. Kylling: Technical note: The libRadtran software package for radiative transfer simulations – description and examples of use, ACP, 5, 1855-1877, 2005

Graphical user interface

The libRadtran software package comes with a graphical user interface (GUI). The GUI may be used to create new and edit existing input files for the uvspec tool. It is has several powerful features, including:

- Logical structure that clearly identifies the various input to the uvspec tool.
- On-line help which is available by pointing the mouse to the relevant input variable.
- Several realistic examples.
- Plotting of various input files.
- Running of uvspec.
- Plotting of various output.

A sample screenshot is shown below. The GUI is under continuous development and new features will be added in the future.

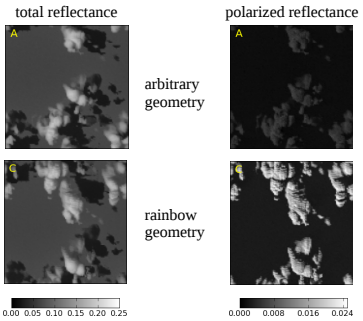


Polarization

Application: Polarized radiance measurements can provide additional information on aerosol type and cloud droplet size distribution. Of particular interest is the rainbow viewing geometry.

Right: Satellite view of cumulus field (unpolarized and polarized reflectances) for two different geometries.

C. Emde, R. Buras, B. Mayer & M. Blumthaler.
The impact of aerosols on polarized sky radiance: model development, validation, and applications. ACP, 10 (2) 383-396, 2010.



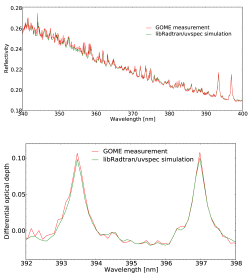
Rotational Raman scattering

Rotational Raman scattering in the Earth's atmosphere explains the filling-in of Fraunhofer lines in the solar spectrum.

Application: Trace gas retrieval correction.

Top: The reflectivity above the Saharan desert as measured by GOME and simulated by the libRadtran package including rotational Raman scattering.

Bottom: The measured and simulated differential optical depths around the Calcium H and K lines.

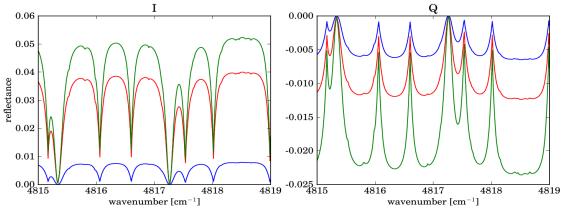


A. Kylling, B. Mayer and M. Blumthaler: Technical note: A new discrete ordinate first-order rotational Raman scattering radiative transfer model - implementation and first results. ACP, 11, 10471-10485, 2011

Efficient line-by-line simulations

Using Absorption Lines Importance Sampling (**ALIS**) high-resolution polarized spectral calculations only need computation times comparable to those of simple 1D (DISORT) calculations.

Application: Trace gas retrieval.



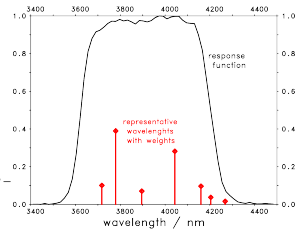
Simulated GOSAT spectra over the ocean. The green line corresponds to a solar zenith angle of 30° (sun glint geometry), red and blue lines correspond to 20° and 60°, respectively.

C. Emde, R. Buras, and B. Mayer. ALIS: An efficient method to compute high spectral resolution polarized solar radiances using the Monte Carlo approach. JQSRT, 112 (10), 1622-1631, 2011.

Absorption parameterization

Application: Modelling broadband radiometer observations, affected by molecular absorption.

Right: Example for representative wavelengths and weights for parameterizing radiometer responses.



S.A. Buehler, V.O. John, A. Kottayil, M. Milz, P. Eriksson.
Efficient radiative transfer simulations for a broadband infrared radiometer – Combining a weighted mean of representative frequencies approach with frequency selection by simulated annealing. JQSRT, 111, 602-615, 2010.