libRadtran user course, lecture # 2

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uvspec: the input file

The `uvspec` model may be run from the command line:

```
uvspec < input_file >  output_file
```

or (bash shell)

```
(uvspec < uvspec.inp > uvspec.out) >& uvspec.err
```

Tips/suggestions

- To generate first input file:
  - Try GUI
  - Look in examples directory for *INP files
- Overview of options:
  - Use GUI
  - Consult libRadtran User's guide for details. Use index at end.
- Use your favorite scripting language or similar (python, perl, R, shell scripts or whatever) for multiple calls to uvspec and other tools.
- Nothing working: developers@libradtran.org, but you may have to be patient. We answer in our sparetime/freetime.

python example

```
"""
Repeated calls to uvspec for a range of solar zenith angles
"""
import numpy as np
import time
import UVspec

szas = np.arange(50,96,2)

OutputFolder='./OUT_SZA/'
Case   = 'UVSPEC_SZA_PP'

for sza in szas:
   UVS = UVspec.UVspec()
   UVS.inp["wavelength"] = '310.0'
   UVS.inp["sza"]          = str(sza)
   UVS.inp["albedo"]          = '0.4'
   UVS.inp["number_of_streams"]        = '12'
   if 'PS' in Case:
      UVS.inp["pseudospherical"] = ''
   UVS.inp["output_user"] = 'lambda sza edir edn eup eglo'

   UVS.WriteInputFile("tmpuvspec.inp", verbose=False)
   UVS.OutputFile=OutputFolder+Case+'_{:05.2f}'.format(sza)+'.out'
   start= time.time()
   UVS.Run(UVS.InputFile,UVS.OutputFile)
   end= time.time()
   runtime= (end-start)
   print sza, start, end, runtime
```

uvspec note

uvspec does the following:

- reads input
- calculates optical properties
- solves RTE
- post processing

uvspec does this for one spectrum
thermal and solar spectral calculations need to be done separately

Radiances, isotropy

```
# Looking downward, upwelling radiation
umu 0.5 1.0
phi 0 90 180 270

# Looking upward, downwelling radiation
umu -1.0 -0.5

# Both up and down (not 0.0=horizontal)
umu -1.0 -0.5  0.5 1.0
```

All (cosine of) angles in increasing order. Also remember `phi0`.

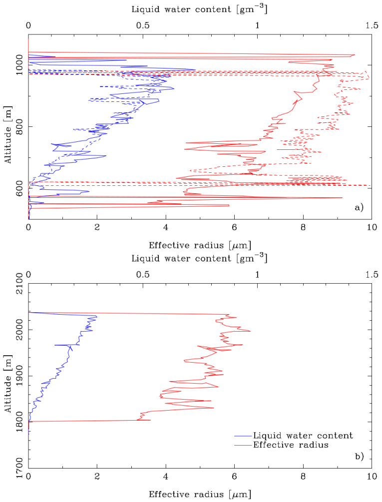
Liquid and ice water clouds

- Liquid and ice water clouds may easily be included in 1D.
- Various optical properties of liquid and ice water clouds are included in libRadtran.
- libRadtran needs vertical profiles of cloud properties.

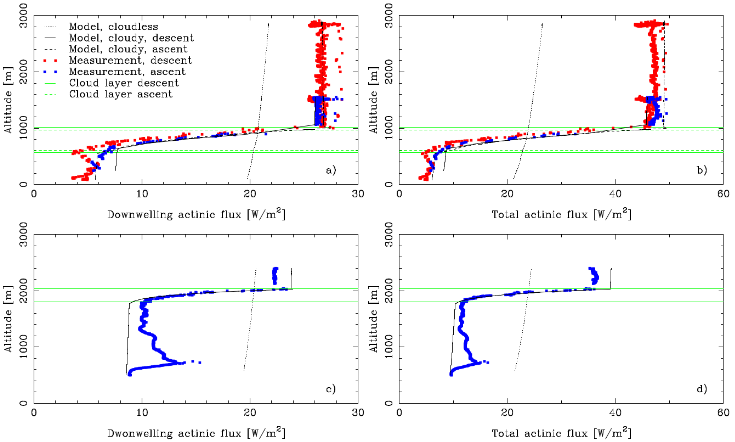
Liquid water cloud optical properties

Cloud properties measured by a Particle Volume Monitor (PVM) and a Fast Forward Scattering Spectrometer Probe (Fast-FSSP) mounted on a Partenavia P68C aircraft.

From Kylling et al. (2005).



Measured and modelled radiation



The actinic flux as measured by instruments on a Partenavia P68C aircraft and simulated by libRadtran.

From Kylling et al. (2005).

Cloud parameterization

wc_file	`1D`, `ipa_files`, `moments`
wc_properties	`hu`, `echam4`, `mie`, `filename`
wc_modify	

`wc_file 1D` (vertical resolution independent from `atmosphere_file`):

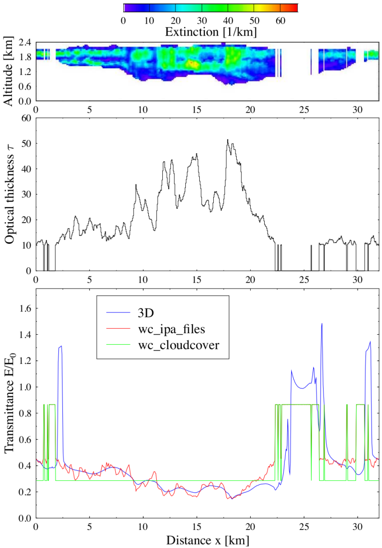
```
#      z      LWC    R_eff
#     (km)  (g/m^3) (um)
      4.000     0    10.0     # The water cloud is located between
      3.000   1.0    10.0     # 2 and 4.0 km. The parameters may
      2.000   1.0    10.0     # vary with altitude.
```

`wc_file ipa_files`:

```
# Filename              Cloud
#                       Fraction
#                       Weight
../examples/WC50_A.DAT 0.5
../examples/WC50_B.DAT 0.3
../examples/WC50_C.DAT 0.2
```

See also `cloud_fraction`, `cloud_overlap`, `cloudcover`.

Cloud cover treatment



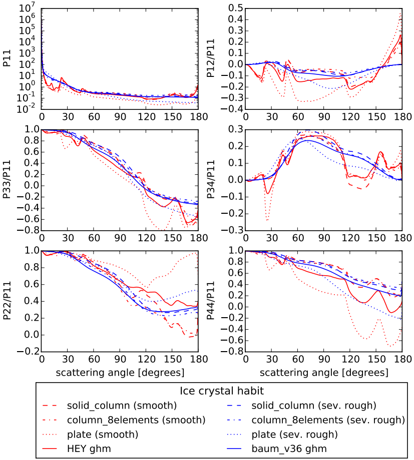
From Mayer and Kylling (2005).

Ice clouds

Ice particles are generally not spherical. libRadtran includes various parameterizations of ice particle optical properties. They are specified by `ic_properties` (not all parameterizations cover both the solar and thermal)

fu	irradiance, heating rates
echam4	irradiance
key	irradiance, heating rates
yang	irradiance, heating rates
baum	radiances
baum_v36	(polarized) radiances
hey	(polarized) radiances
yang2013	(polarized) radiances
filename	(polarized) radiances

See `ic_habit`, Table 5 and Appendix A in Emde et al. (2016).



Rainbow

Today's exercises:

- Calculate solar and thermal spectra for cloudy sky at top and bottom of the atmosphere
- Do this for water cloud, ice cloud and both.
- In the thermal IR. Calculate top of the atmosphere (TOA) brightness temperature for 10.8 and 12.0 μm and take the difference for cloudless sky, water cloud and ice clouds.
- Try the independent pixel approximation.
- What happens to the solar radiance distribution under a cloudy sky?
- Present results

Hints:

- example input files: `UVSPEC_WC.INP`, `UVSPEC_IC_WC.INP`, `UVSPEC_WC_IPA_FILES.INP`
- options `wc_file`, `ic_file`, `wc_properties`, `ic_properties`

References I

Emde, C., Buras-Schnell, R., Kylling, A., Mayer, B., Gasteiger, J., Hamann, U., Kylling, J., Richter, B., Pause, C., Dowling, T., and Bugliaro, L.: The libRadtran software package for radiative transfer calculations (version 2.0.1), Geoscientific Model Development, 9, 1647–1672, https://doi.org/10.5194/gmd-9-1647-2016, URL http://www.geosci-model-dev.net/9/1647/2016/, 2016.

Kylling, A., Webb, A. R., Gobbi, R. K. G. P., Ammannato, L., Barnaba, F., Bais, A., Kazadzis, S., Wendisch, M., Jäkel, E., Schmidt, S., Kniffka, A., Thiel, S., Junkermann, W., Blumthaler, M., Silbernagl, R., Schallhart, B., Scmitt, R., Kjeldstad, B., Thorseth, T. M., Scheirer, R., and Mayer, B.: Spectral actinic flux in the lower troposphere: measurement and 1-D simulations for cloudless, broken cloud and overcast situations, Atmos. Chem. Phys., 5, 1975–1997, 2005.

Mayer, B. and Kylling, A.: Technical note: the libRadtran software package for radiative transfer calculations-description and examples of use, Atmos. Chem. Phys., 5, 1855–1877, 2005.