Extended aerosol properties based on OPAC

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18 September 2008

ESAS-Light Progress Meeting 2

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Oberpfaffenhofen, Germany

OPAC aerosols (Hess, 1998)

inso	Water insoluble part (mostly soil particles, some organic material
waso	Water soluble part (sulfates, nitrates; also organic water soluble substances; often used to describe anthropogenic aerosol)
soot	Absorbing black carbon
ssam	Sea salt, accumulated mode (different modes to describe wind-speed dependant increase of amount of large particles)
sscm	Sea salt, coarse mode
minm	Mineral aerosol; nuclear (different modes since: increased amount of large particles for increasing turbitivity)
miam	Mineral aerosol, accumulated mode
micm	Mineral aerosol, coarse mode
mitr	Transported mineral aerosol (less large particles)
suso	Sulfate aerosol (used for Antarctic aerosol and stratospheric background aerosol, not suitable for anthropogenic aerosol)

Mie calculations

OPAC database not sufficient to simulate polarization, since it does not include scattering phase matrix

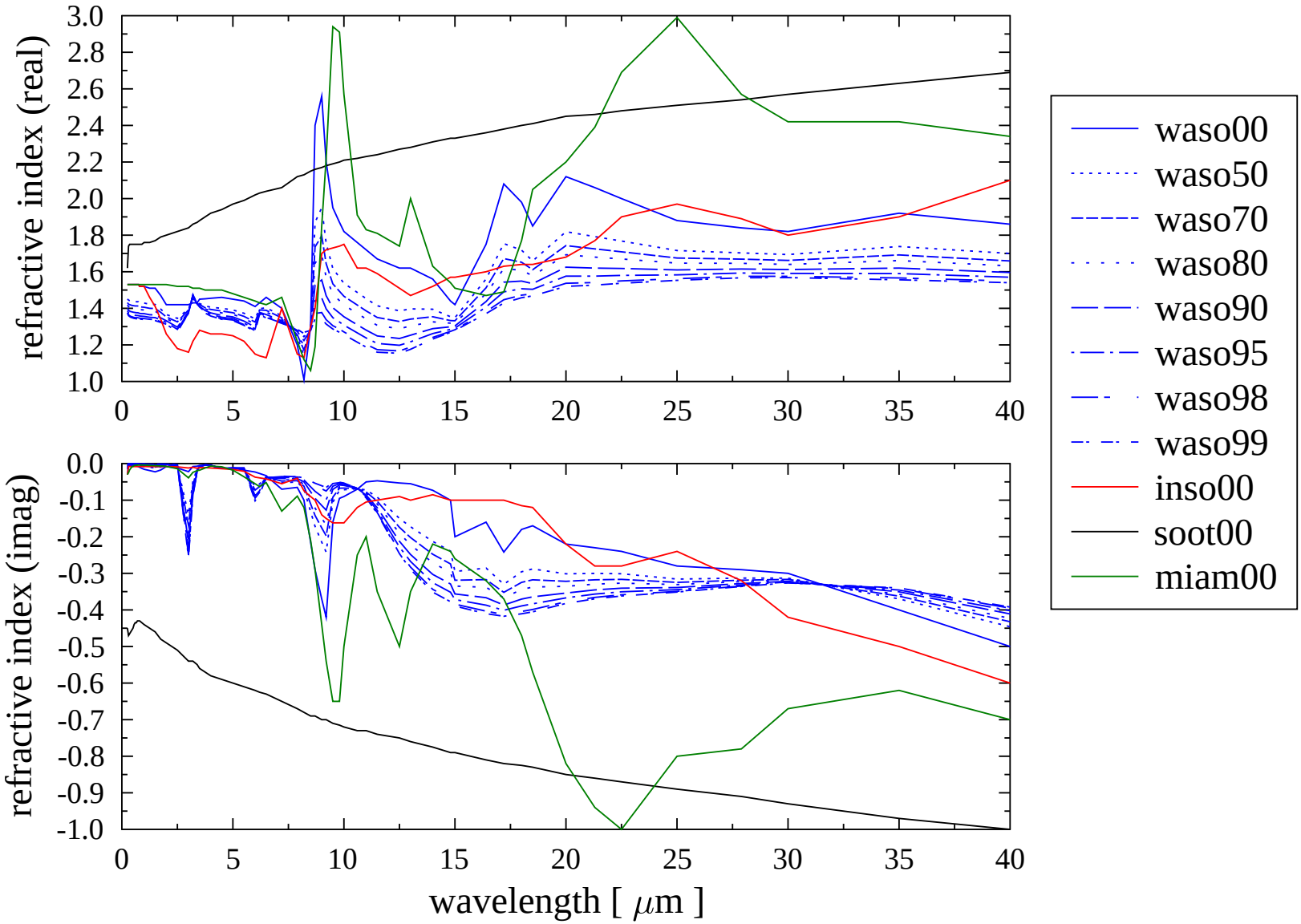
Inputs for Mie tool:

- Refractive index
- Size distribution (log-normal):

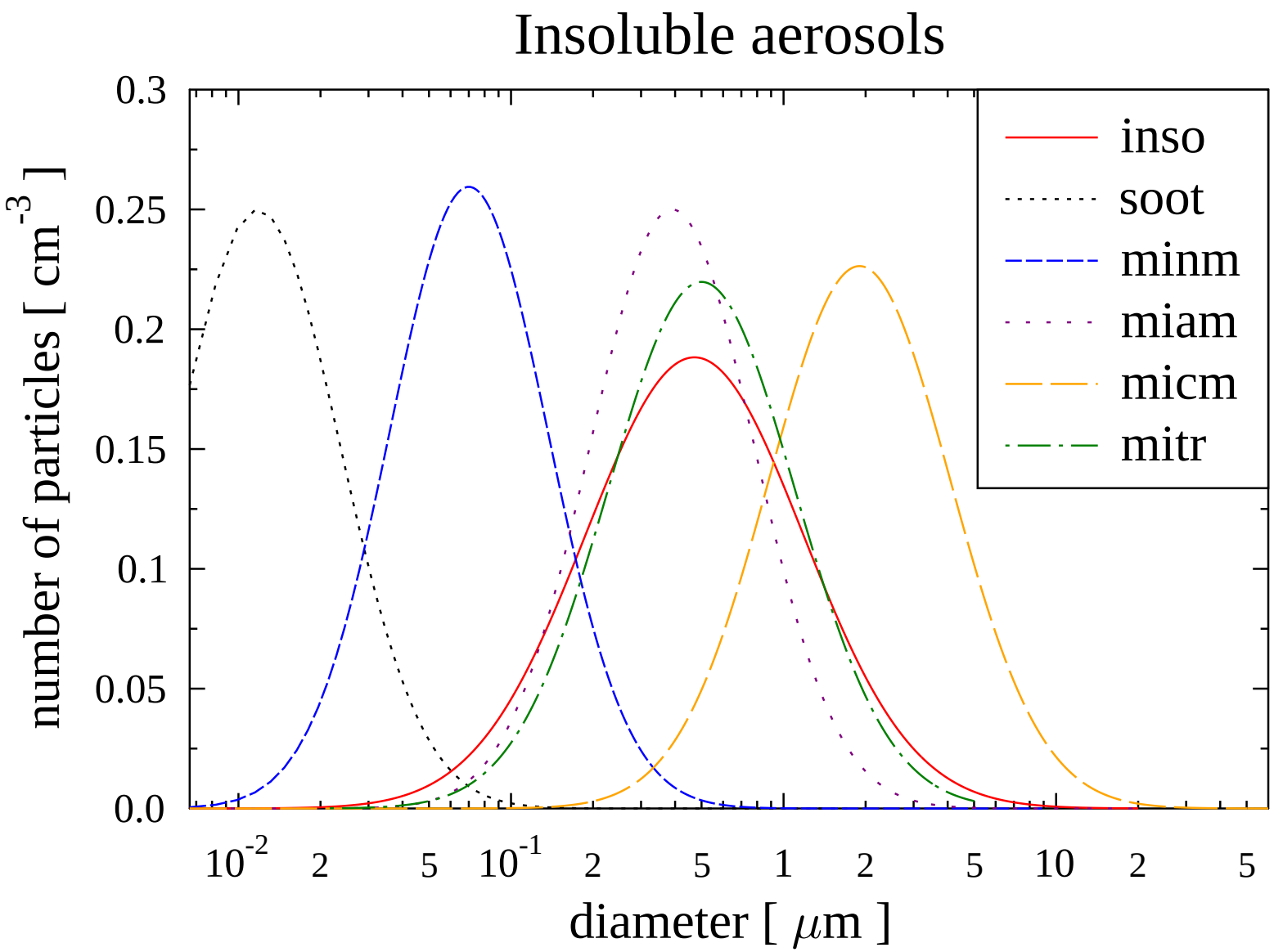
$$\frac{dN_i(r)}{dlogr} = \frac{N_i}{\sqrt{2\pi}\log_{10}\sigma_i} \exp\left(-\frac{1}{2}\left(\frac{\log_{10} r - \log_{10}(r_{modN,i})}{\log_{10}\sigma_i}\right)\right) \quad (1)$$

  Parameters σ_i and $r_{modN,i}$. Furthermore density ρ_i and aerosol mass per cubic meter air M_i^* given, from which N_i can be calculated.

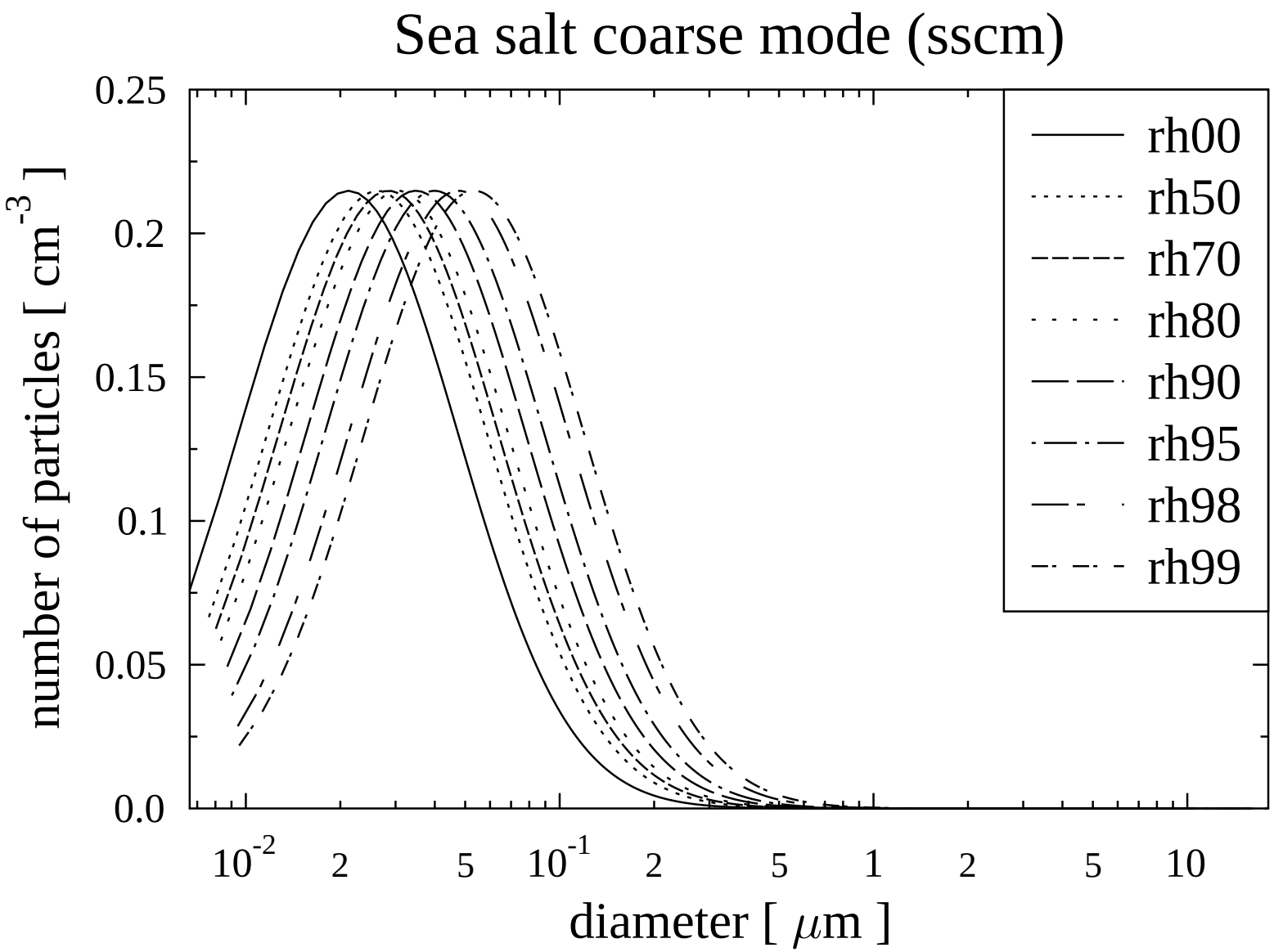
OPAC database - Refractive index example



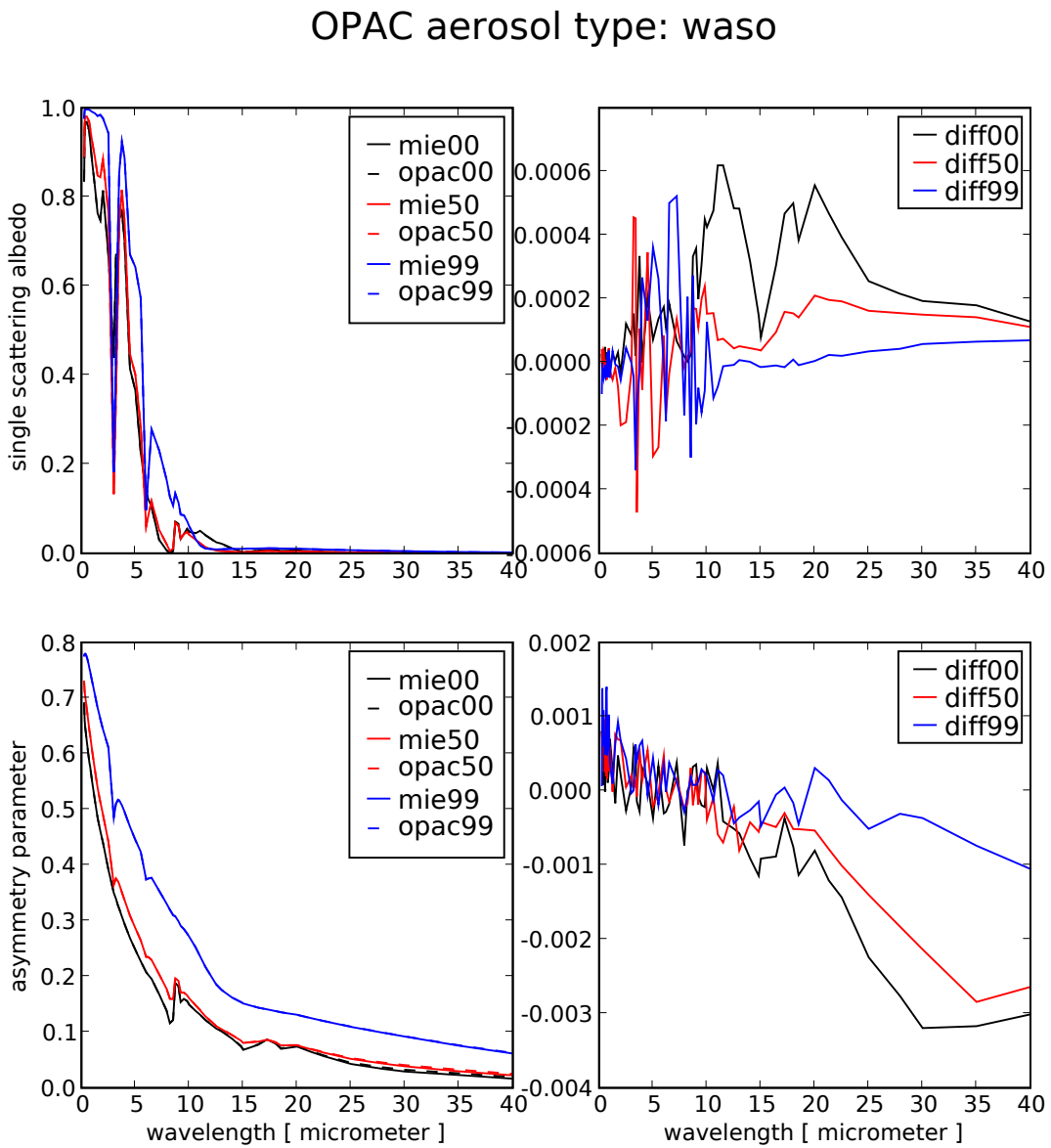
OPAC database - Size distributions



OPAC database - Size distributions



Comparison of libRadtran database to original OPAC

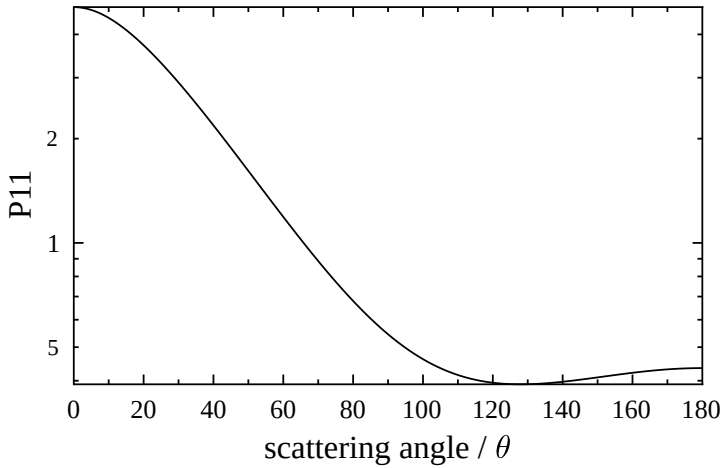


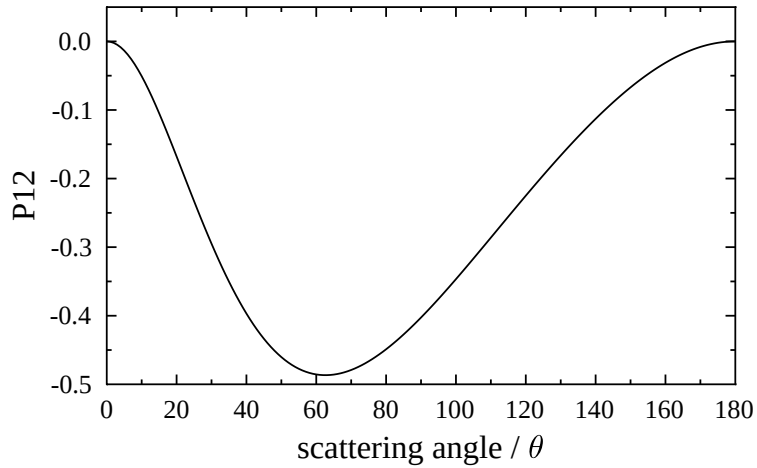
Single scattering albedo and asymmetry parameter compared to original OPAC database to check consistency of Mie calculations

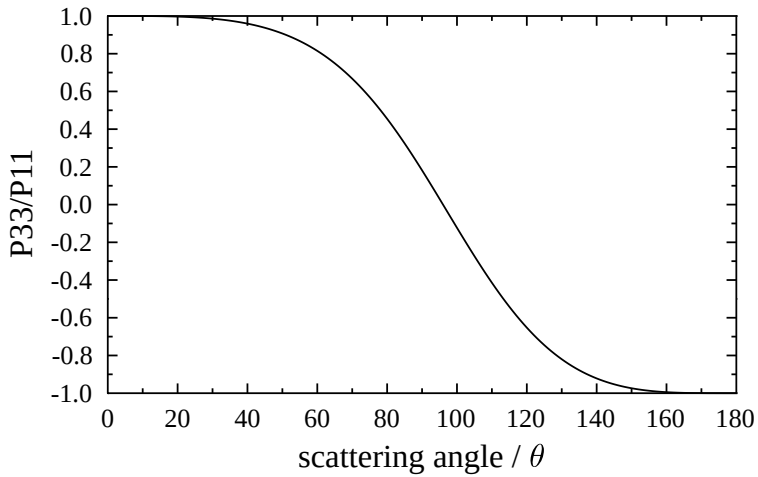
$\Rightarrow$ very good agreement

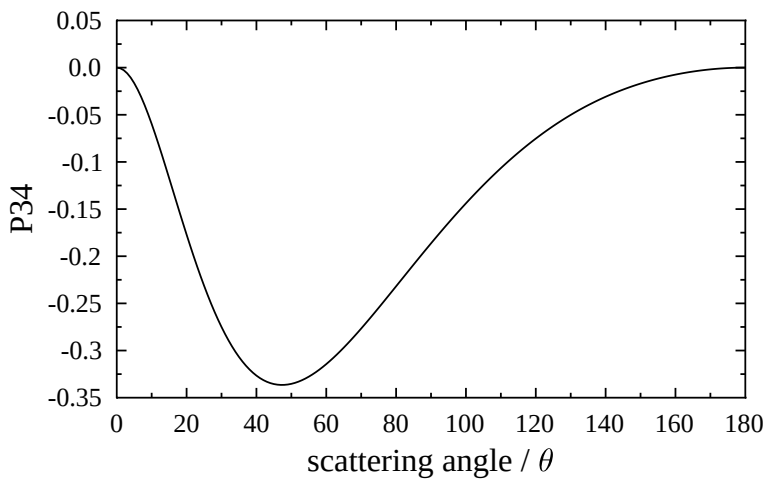
Scattering phase matrix for soot

Phase matrix for OPAC aeosol type soot, λ= 340 nm



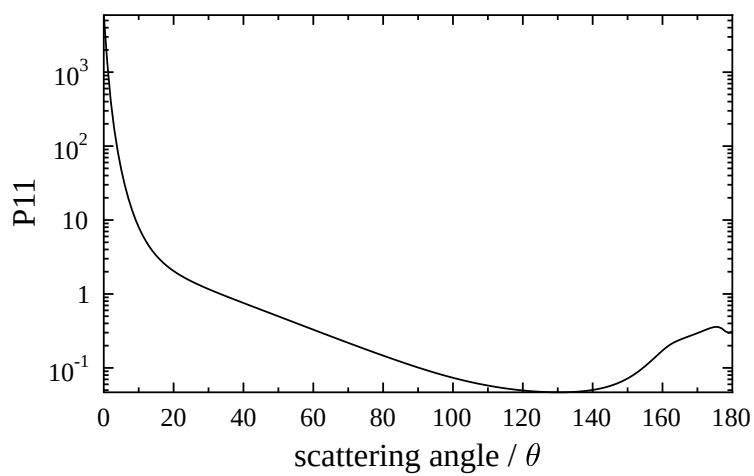


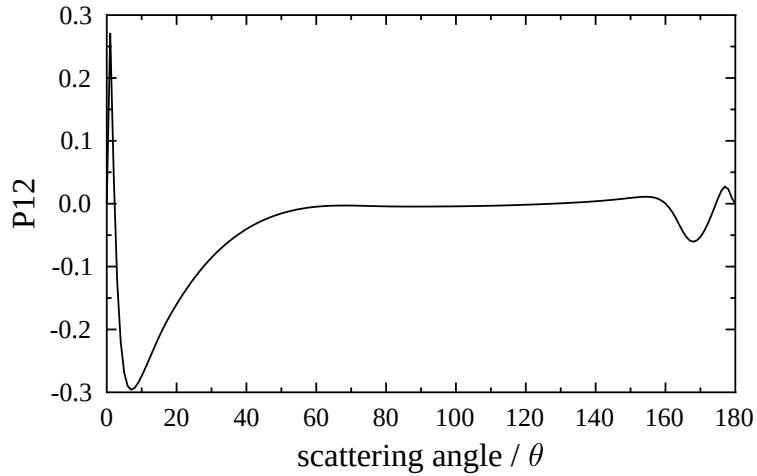


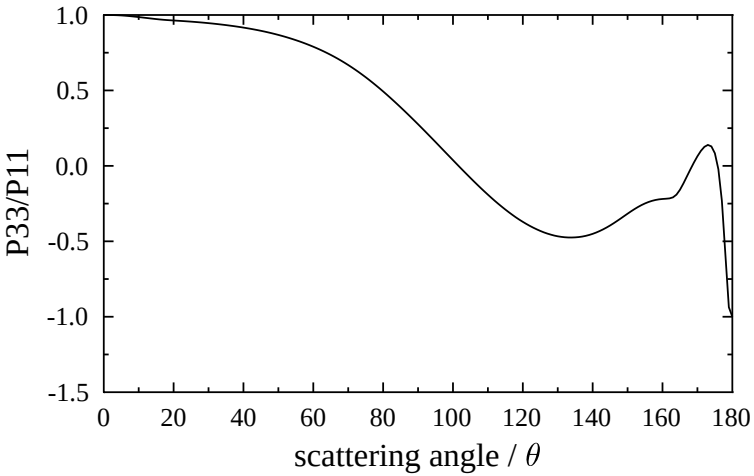


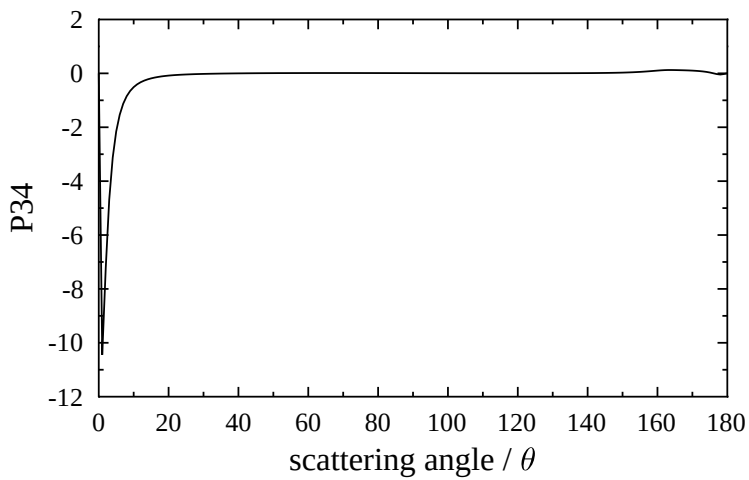
Scattering phase matrix for insoluble aerosol

Phase matrix for OPAC aeosol type inso, λ= 340 nm



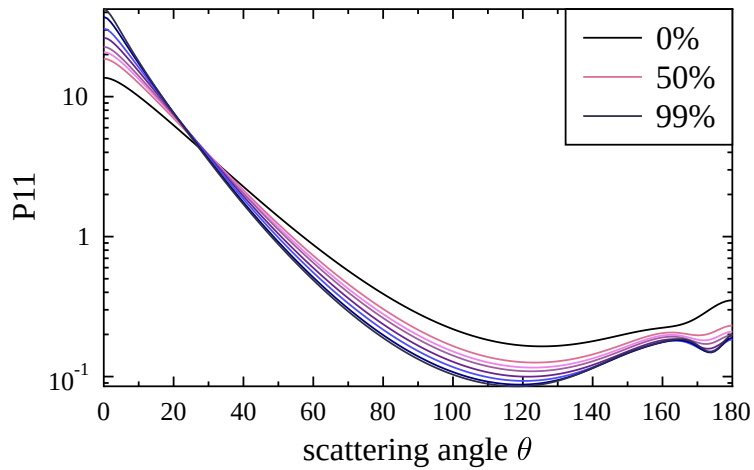


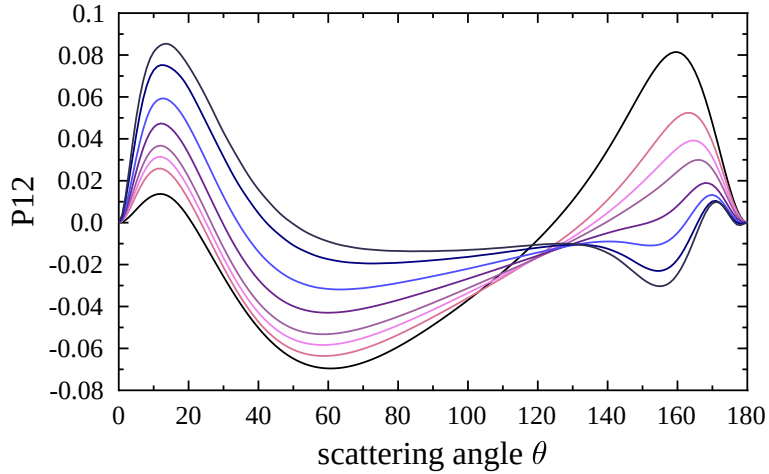


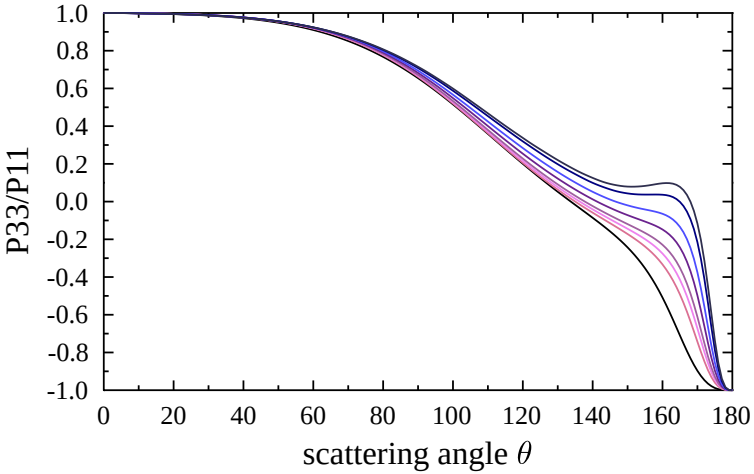


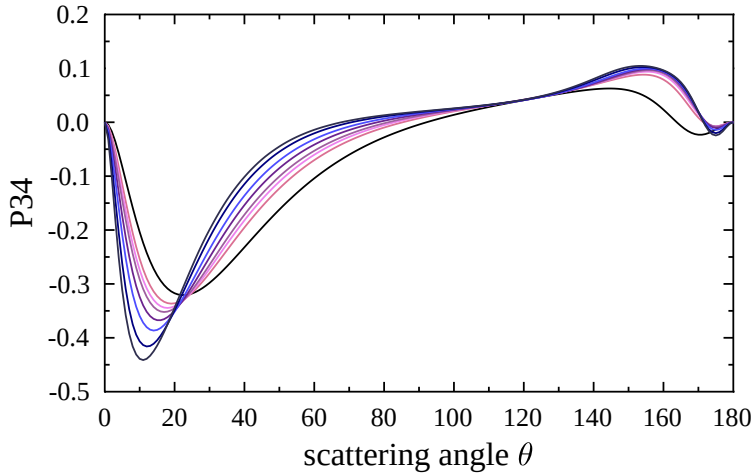
Scattering phase matrix for water soluble aerosol

Phase matrix for OPAC aeosol type waso, λ= 340 nm

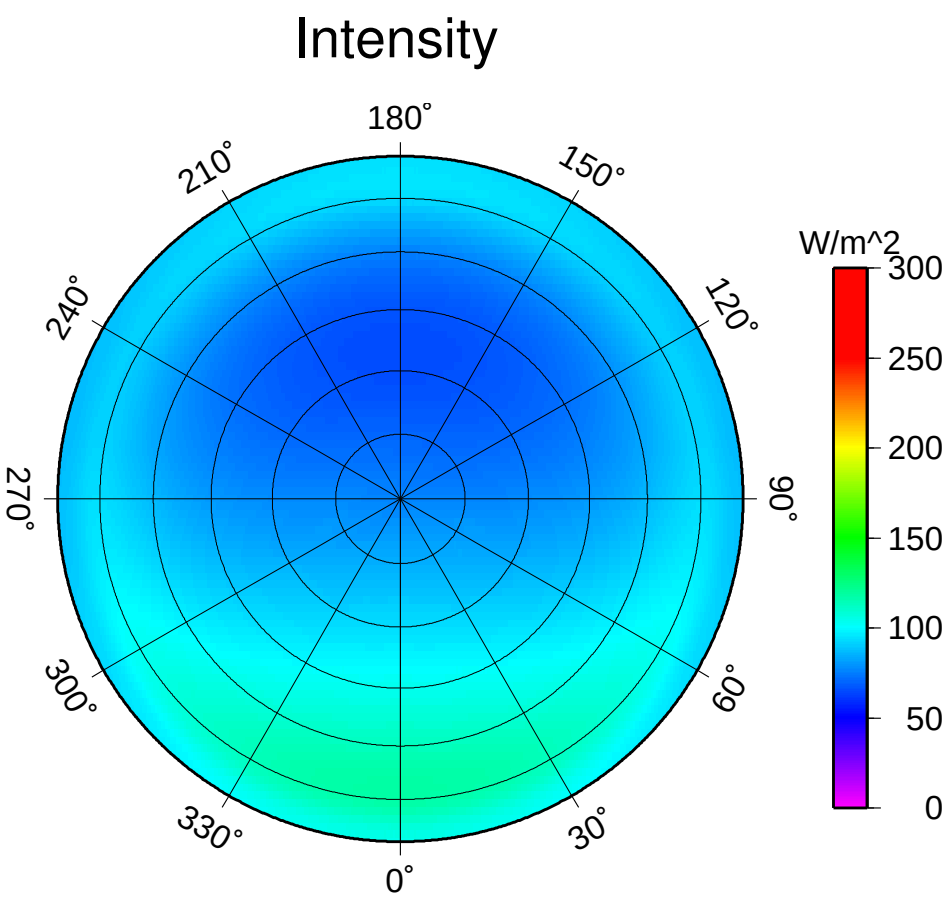


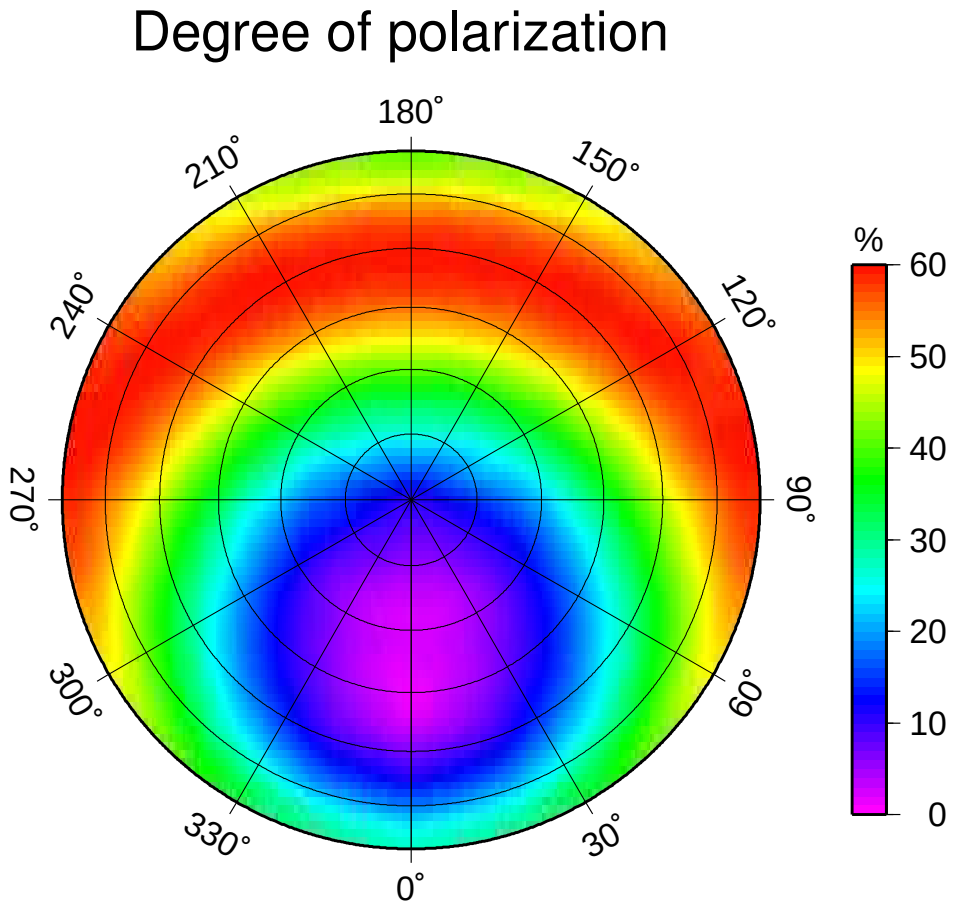






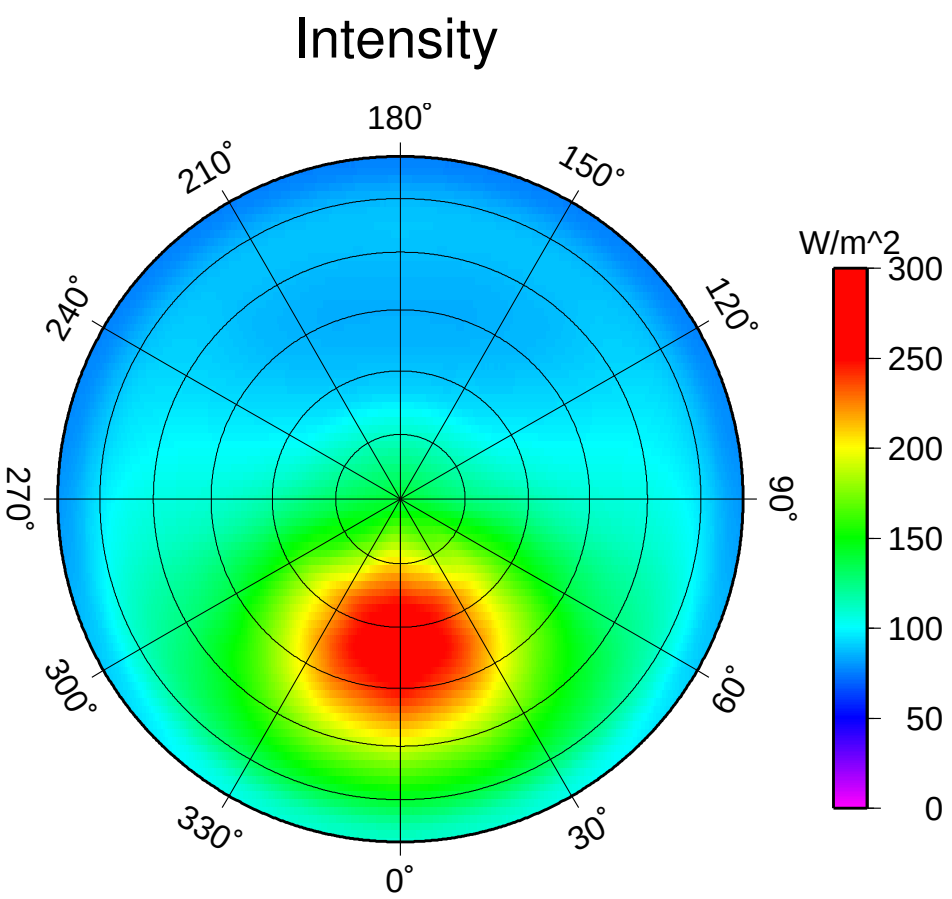
Sky radiance - Rayleigh

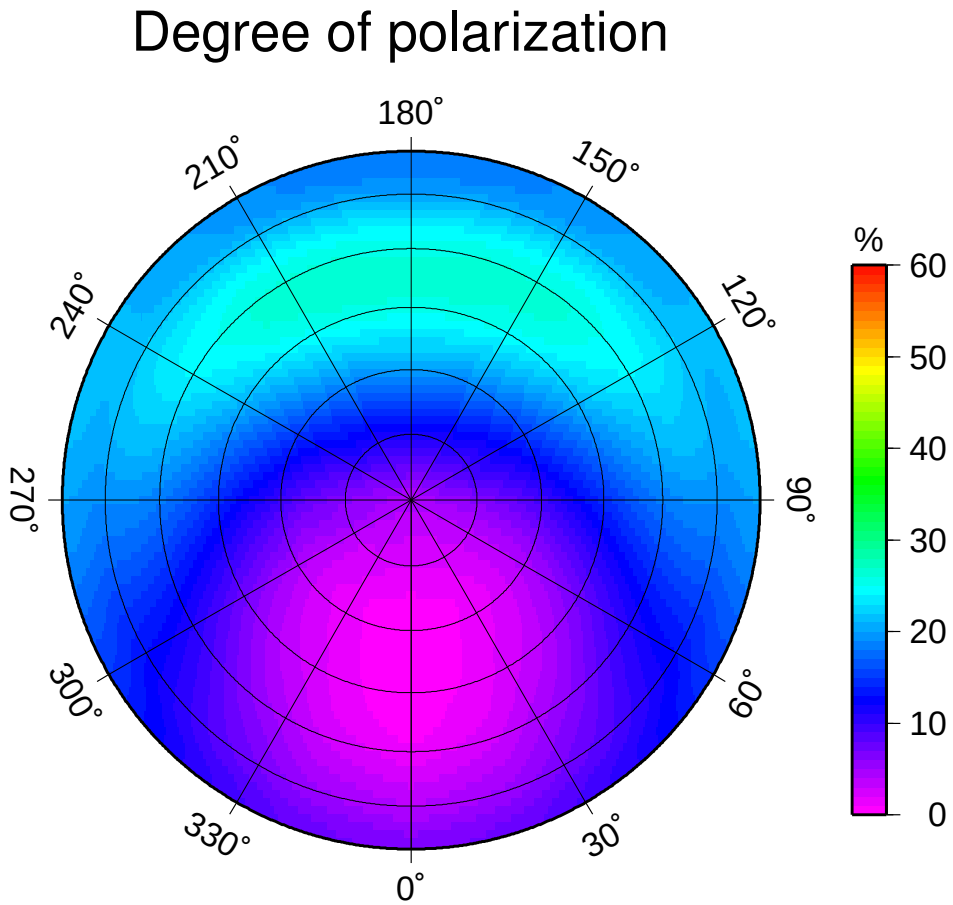




λ=340 nm, solar zenith angle 30°
pure Rayleigh scattering

Sky radiance - Rayleigh + Aerosol





λ=340 nm, solar zenith angle 30°
water soluble aerosol, optical thickness 0.5

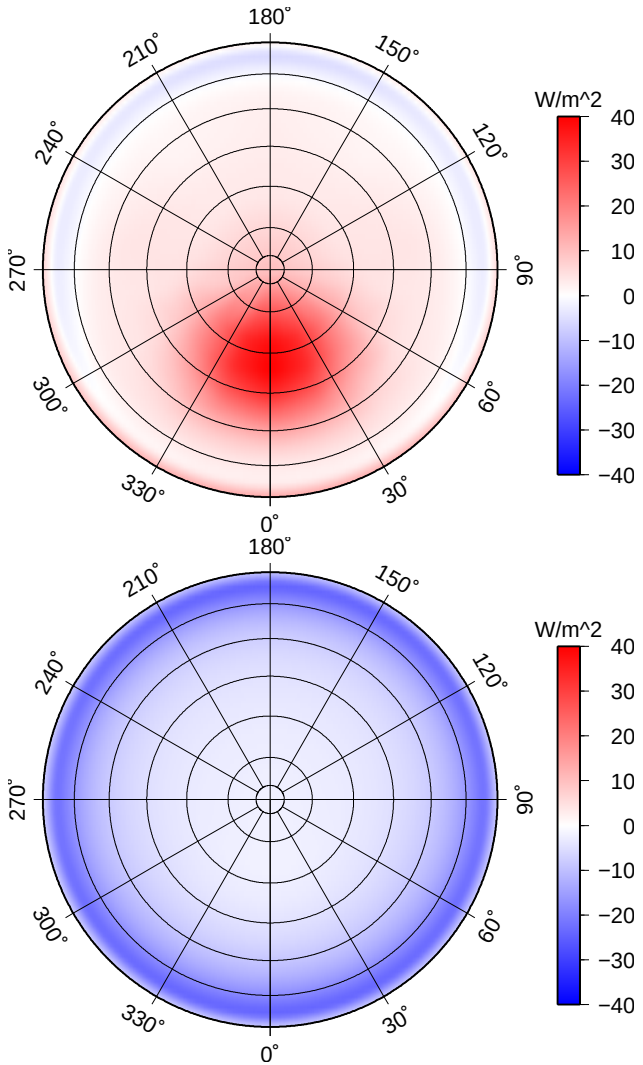
Differences: Rayleigh - Aerosol

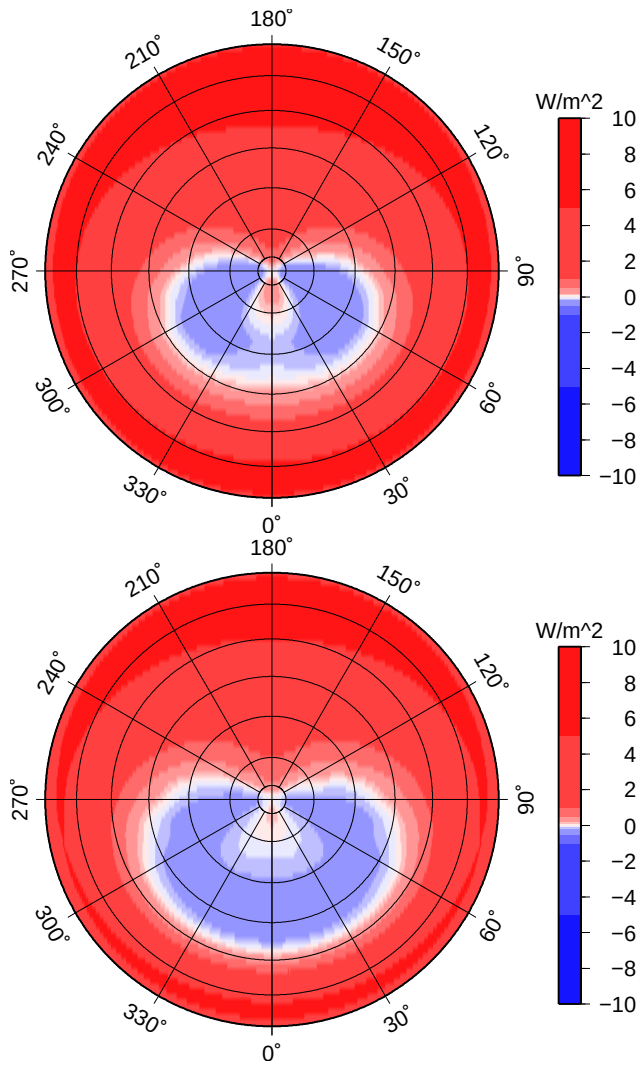
Intensity

Stokes component Q

sea salt

soot





λ=340 nm, solar zenith angle 30°

Conclusions and Outlook

- Generated an extended OPAC database using Mie program by Wiscombe
- Checked consistency with original OPAC database
- Reading routine for OPAC data
- New OPAC database can be used with all *libRadtran* solvers
- Polarized radiative transfer calculations are so far possible with *polradtran*, in future also with *mystic*
- Further work:
  - Allow arbitrary aerosol mixtures of OPAC types that can be specified by the user
  - Include documentation in libRadtran user guide