Radiative transfer solver MYSTIC

Monte carlo code for the phYSically correct Tracing of photons In Cloudy atmospheres
Mayer [1999, 2000], *Emde and Mayer* [2007]

Implementation of polarization requires:

- 4 component Stokes vector instead of only intensity (weight vector)
- Extended optical properties data (phase matrix, extinction matrix, absorption vector)
- Rotate scattering phase matrix form scattering frame in model coordinates.

Polarization in MYSTIC

- Fully implemented.
- Combination of several methods to make code accurate and at the same time efficient:
  - Local estimate method
  - Forward and backward mode
  - 1D or 3D simulations
  - spherical geometry in 1D mode
- Validation (comparison to polradtran) started:
  - Rayleigh scattering: very good agreement (max. difference about 1%)
  - Aerosols and clouds: MYSTIC solver superior to polradtran for aerosols with enhanced forward scattering (typical in UV/Vis)

Radiance field for Rayleigh scattering

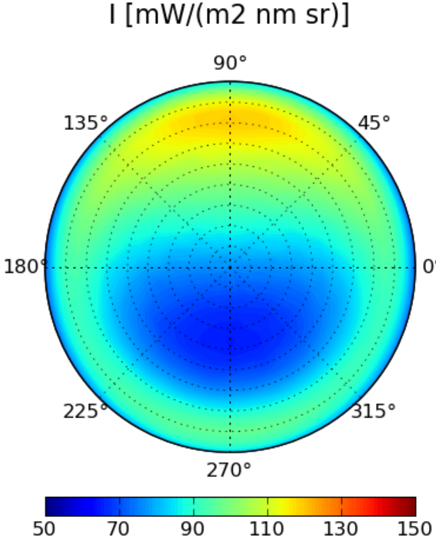
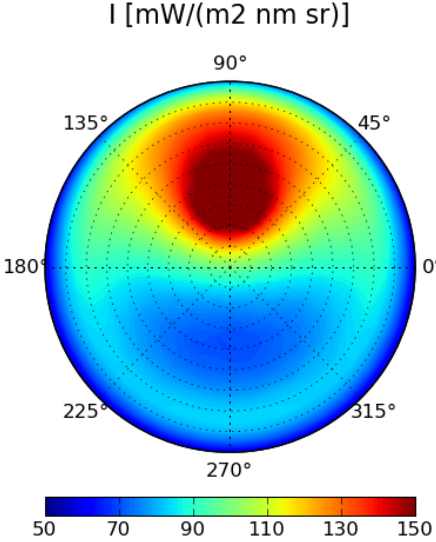


Figure: Intensity and degree of polarization at the surface for a Rayleigh atmosphere at 340 nm.

Radiance field for aerosol scattering



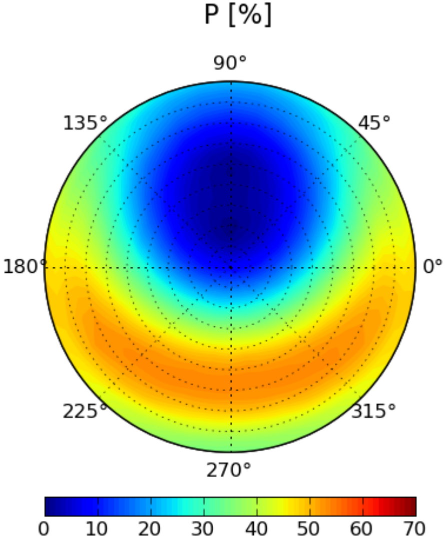


Figure: Intensity and degree of polarization at the surface for a Rayleigh atmosphere with average aerosol conditions at 340 nm.

Rayleigh scattering, principle plane

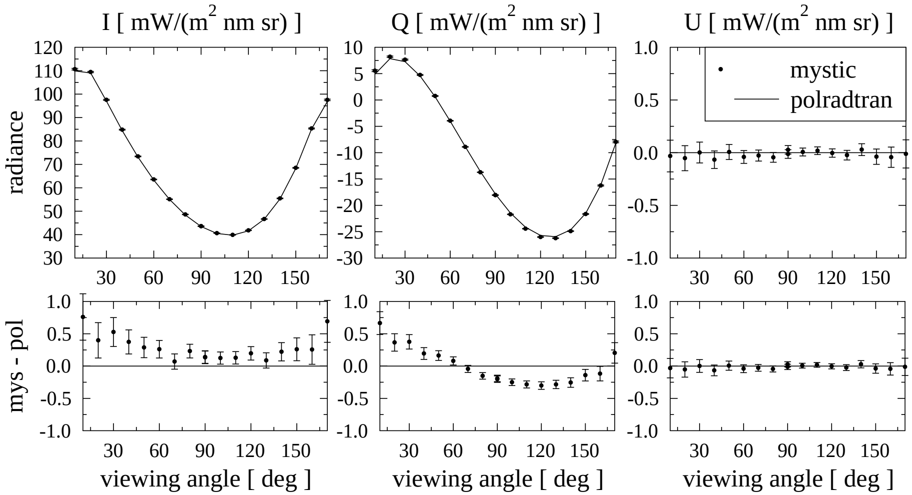


Figure: Stokes components calculated for a clear sky atmosphere for a solar zenith angle of 60°at 350 nm wavelength. The principal plane is shown, i.e. the y-axes corresponds to the viewing zenith angle.

Rayleigh scattering, almucanter plane

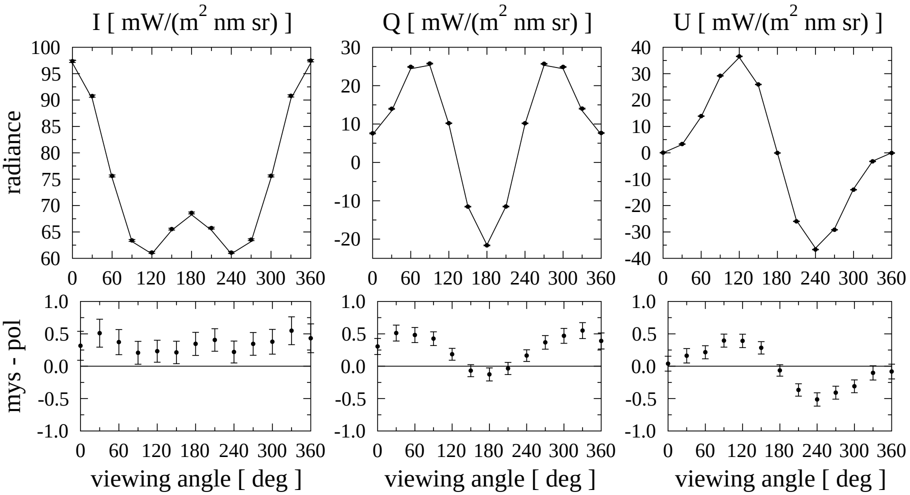
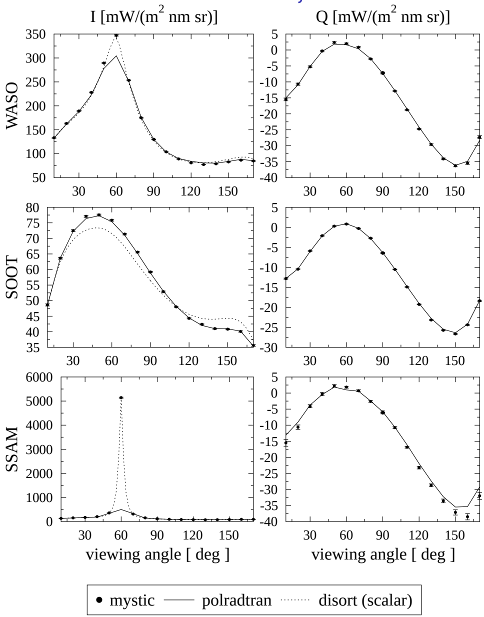


Figure: Stokes components calculated for a clear sky atmosphere for a solar zenith angle of 60°at 350 nm wavelength. The almucanter plane is shown, i.e. the y-axes corresponds to the viewing azimuth angle.

Aerosol simulation, AOT 0.4



Stokes components I and Q

aerosol optical thickness 0.4

aerosol types as defined in OPAC, i.e. water soluble (WASO), soot, and sea salt accumulated mode (SSAM)

Limitations of polradtran

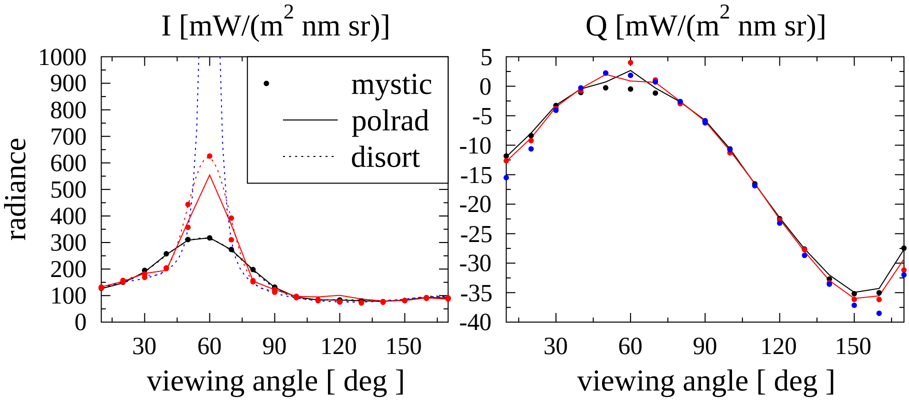
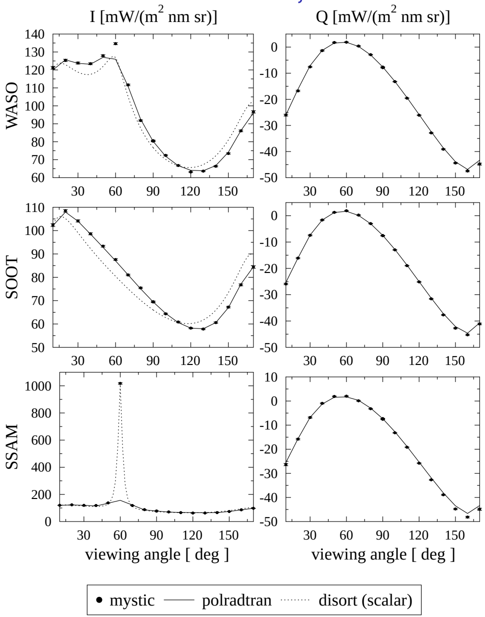


Figure: Stokes components I and Q calculated for an aerosol optical thickness of 0.4 assuming that all aerosol is sea salt (accumulated mode). The colors correspond to different numbers of Legendre polynomials that are used to decompose the phase matrix: black - 8 polynomials, red - 16 polynomials, blue - 2000 polynomials

Aerosol simulation, AOT 0.05



Stokes components I and Q

aerosol optical thickness 0.05

aerosol types as defined in OPAC, i.e. water soluble (WASO), soot, and sea salt accumulated mode (SSAM)