Proposal for a new IRC Working Group: International Polarized Radiative Transfer IPRT

Bernhard Mayer, Claudia Emde

Meteorological Institute (MIM)
Ludwig-Maximilians-University (Munich)

June 30, 2011

Motivation

An increasing number of remote sensing instruments and ESA/NASA/JAXA/... phase-A studies use or require

- polarization (GOSAT, SCIAMACHY, PARASOL, EarthCARE, CLARREO, GLORY successor, AERONET/Cimel ...)
- in plane-parallel or spherical geometry (SCIAMACHY, ...)
- for 1D and 3D scenes.

To develop retrievals and for end-to-end simulations, highly advanced radiative transfer models and optical property datasets for aerosols, water and ice clouds, as well as surface reflectivity are required.

Motivation – Polarization provides information about aerosol and clouds

C. Emde et al.: The impact of aerosols on polarized sky radiance

Atmos. Chem. Phys., 10, 383–396, 2010

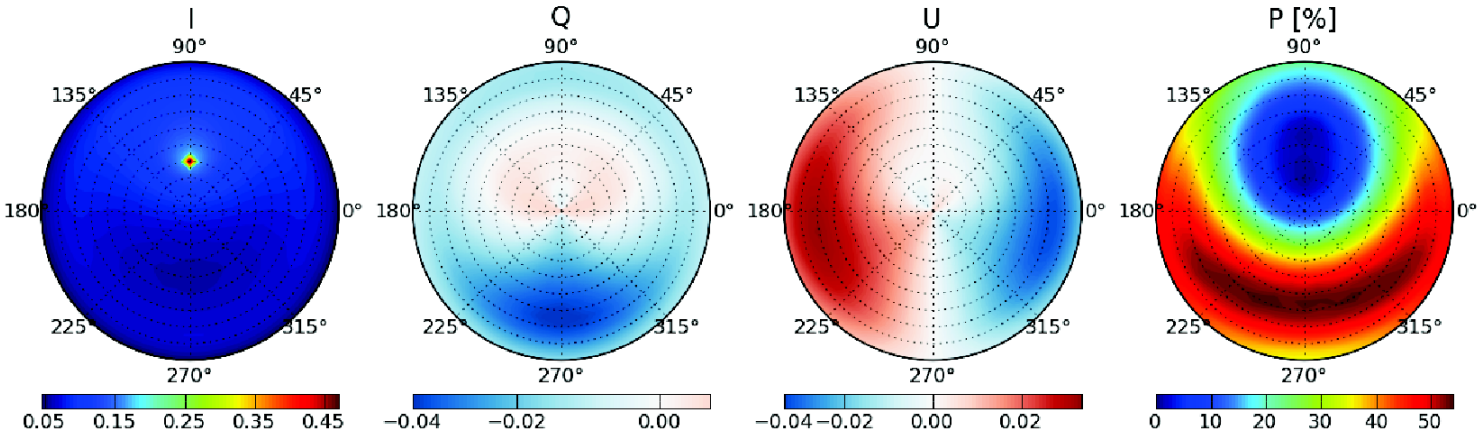


Fig. 6. Stokes components and degree of polarization at 350 nm for a molecular atmosphere with typical aerosol conditions ("continental average" mixture as defined in OPAC with an optical thickness of approximately 0.16).

Status of polarized radiative transfer

- Several (but surprisingly few) radiative transfer models are available which can handle realistic aerosol and cloud scattering phase matrices
- Computational times are extremely high compared to scalar calculations
- Few comparisons have been done, mostly excluding complex scattering phase matrices
- Only few benchmark data are available and these are difficult to find (e.g. Coulson et al., 1960: Tables Related to Radiation Emerging from a Planetary Atmosphere with Rayleigh Scattering, University of California Press.)
- Polarized optical property data for aerosols and ice clouds and surface reflectivity are not easily available

Example of a good model comparison

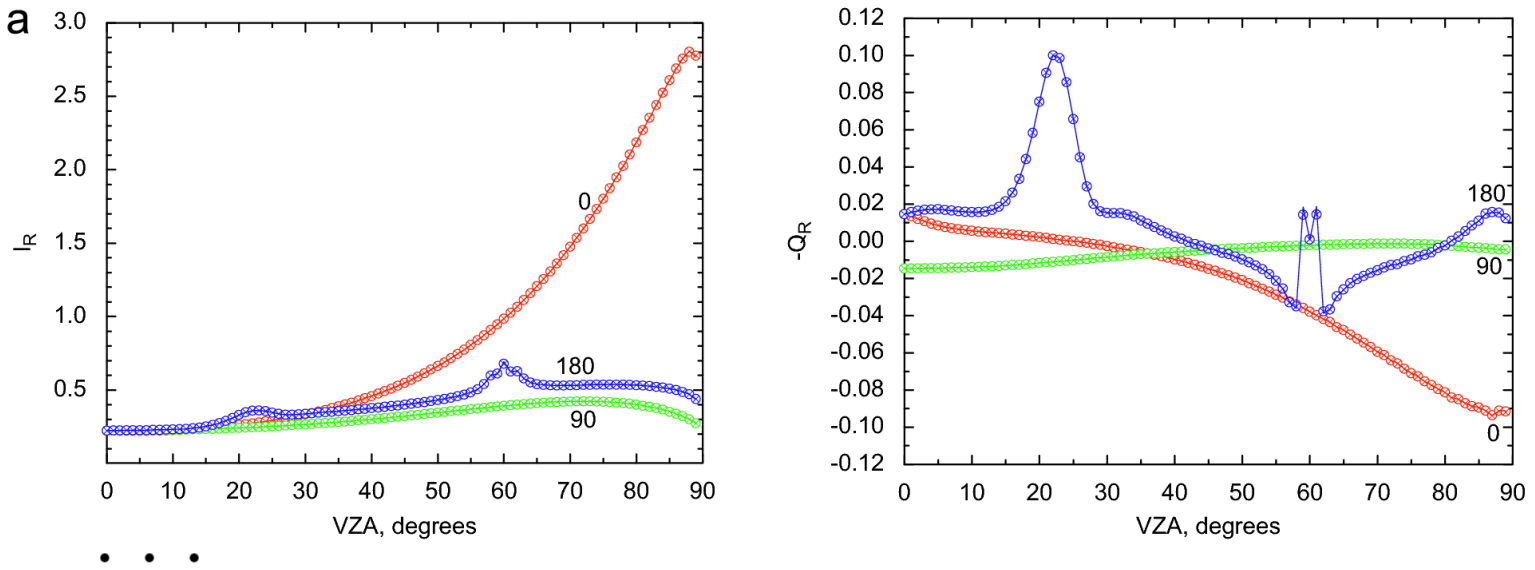
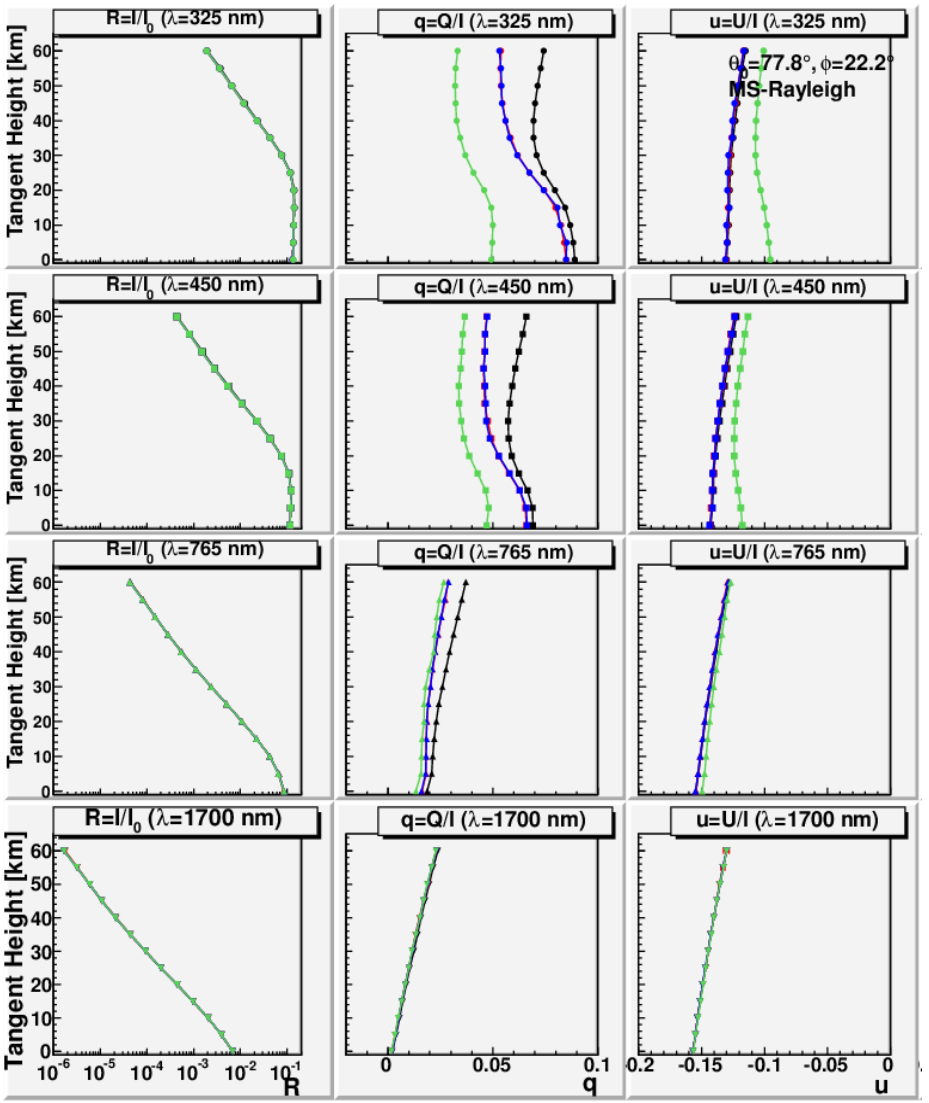


Fig. 4. (a) The normalized Stokes vector elements for the cloud layer scattering case in the reflected light (line—SCIATRAN, circles—*Pstar*, crosses—MYSTIC). The zenith incidence angle is 60° and relative azimuths are 0°, 90°, and 180°. Azimuths counter clock-wise. The third Stokes parameter vanishes at ϕ=0°, 180° and (b) The same as in (a) except for the transmitted light.

Example of a not-so-good model comparison



(Figure by P. Liebig, Uni Bremen)

Simulation for SCIAMACHY limb scan

Example of a model/measurement comparison

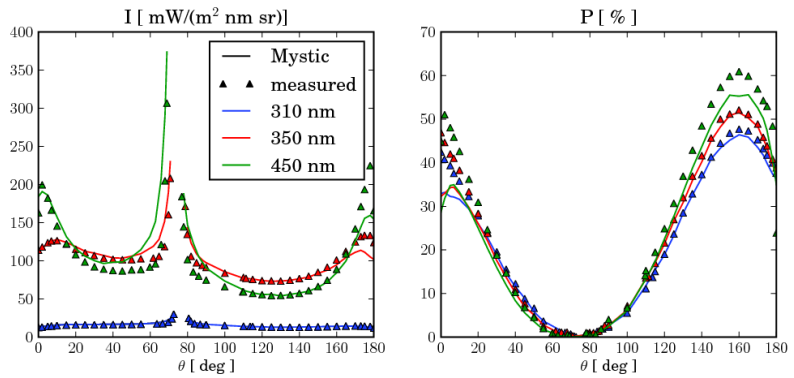


Fig. 12. Normalized intensity and degree of polarization simulated for an aerosol mixture of mineral and water soluble particles (3 June 2005, 12:00 UTC). The aerosol optical thickness was 0.06. Clouds below the measurement site are taken into account using an effective surface albedo of 0.2.

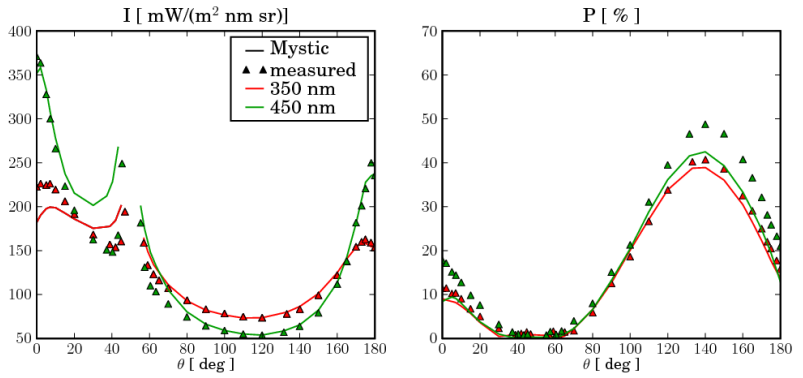


Fig. 13. Intensity and degree of polarization simulated for an aerosol mixture of mineral and water soluble particles (12 June 2005, 10:00 UTC). The aerosol optical thickness was 0.06. Clouds below the measurement site are taken into account using an effective surface albedo of 0.5.

Needs

- Model comparison studies and benchmark results
- Faster, publically available polarized codes
- Publically available optical property databases for non-sperical particles (aerosol, ice clouds), possibly oriented particles, as well as surface BPDFs

Aims of the new working group IPRT

Create a forum similar to I3RC and RAMI for polarization (including spherical geometry, 3D) in order to

- bring the community together (workshops, webpage)
- compare and improve models
- provide benchmark results
- provide information about free codes
- develop new and faster, publically available codes
- provide input data (scattering matrices, BPDFs – bidirectional polarization distribution functions, ...)

Organisation

- Webpage hosted at LMU Munich
- Initial funding: ESA-Project ESASLight2 (Generic Radiative Transfer Toolbox for Earth Environment); base funding from LMU
- Workshops at nice locations ;-)

Workshop location: UFS Schneefernerhaus, 2650 a.s.l.

Proposed Group Members

Bernhard Mayer	LMU Munich, Germany	✓
Claudia Emde	LMU Munich, Germany	✓
Michael Mishchenko	NASA GISS, USA	✓
Alex Kokhanovsky	Uni Bremen, Germany	✓
Otto Hasekamp	SRON, Netherlands	✓
Francois-Marie Bréon	IPSL, France	✓
Ping Yang	UTexas, USA	✓
Dave Diner	NASA JPL, USA	
Yoshifumi Ota	NIES, Japan	
Oleg Dubovik	LOA, France	
Eleonora Zege	Institute of Physics, Minsk, Belarus	✓
Minzheng Duan	LAGEO, China	

Further suggestions?