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Importance of polarization for remote sensing of the Earth's atmosphere

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Solar radiation entering the top of the Earth's atmosphere becomes polarized due to its interaction with atmospheric molecules and particles. The degree of polarization depends on the type of scattering event. Numerous studies show that the use of scalar radiation transfer (RT) can lead to significant errors in simulated top-of-atmosphere radiances: more than 10% for a molecular atmosphere, about 5% for an aerosol atmosphere, and up to 6% for a mixed (aerosol + molecular) atmosphere. Radiation can also be significantly polarized by land surfaces such as snow (5-25%), ice (0-40%), sand (0-15%) and vegetation (2-23%).

Accounting for radiation polarization requires the utilization of rigorous vector RT equations based on the Stokes parameters formalism. Despite that accurate vector RT codes are much slower than their scalar counterparts, more and more researchers acknowledge the necessity of using a vector RT code when dealing with the UV or visible spectral ranges.

We will demonstrate the importance of accounting for polarization with the help of the sophisticated RT package comprised of several codes, namely, VLIDORT v2.5 (R. Spurr, RT solutions, USA), SPHER and T-MATRIX (M. Mishchenko, NASA GISS, USA), and an auxiliary atmospheric model. VLIDORT is an advanced linearized RT body for solving vector/scalar RT problems of various degree of complexity through the accurate computation of all Stokes components. It also contains a set of different BRDF (Bidirectional Reflectance Distribution Functions) subroutines allowing one to easily model different anisotropic surfaces. Aerosol physical properties, such as extinction cross-section, single scattering albedo and scattering matrix coefficients, for spherical and non-spherical particles are calculated by SPHER and T-MATRIX. The auxiliary atmospheric part includes the options to use one of the six standard models (subarctic summer/winter, midlatitude summer/winter, tropical and US standard 1976) or to enter a user-defined model.

Due to the presence of VLIDORT, the package is perfectly suitable for modelling measurements taken by ground- and space-based instruments. It is also a useful tool for creating "polarization correction" look-up tables which are often used to correct the total intensity simulated with a scalar code. We will demonstrate its utility for modelling POLDER(-2) data and for computing a polarization correction database for ozone retrievals from space-borne nadir UV-Visible sensors like GOME(-2) and SCIAMACHY.