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The impact of aerosols on polarized sky radiance: model development, validation, and applications

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Abstract. Although solar radiation initially is unpolarized when entering the Earth's atmosphere, it is polarized by scattering processes with molecules, water droplets, ice crystals, and aerosols. Hence, measurements of the polarization state of radiation can be used to improve remote sensing of aerosols and clouds. The analysis of polarized radiance measurements requires an accurate radiative transfer model. To this end, a new efficient and flexible three-dimensional Monte Carlo code to compute polarized radiances has been developed and implemented into MYSTIC (Monte Carlo code for the phYSically correct Tracing of photons In Cloudy atmospheres). The code has been extensively validated against published benchmark results. The polarized downwelling radiation field is calculated for various aerosol types showing the high sensitivity of polarized ultraviolet radiances to the particle microphysics. Model simulations are compared to ground based measurements and found to be qualitatively in good agreement. Quantitative differences can be attributed to the assumed aerosol models based on the OPAC aerosol database, which does not include exactly the types of aerosols that have been observed. This comparison to the measurements shows that there is a high potential to retrieve information about the aerosol type from polarized radiance measurements.

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