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Reflection and transmission of solar light by clouds: asymptotic theory

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Abstract. The authors introduce a radiative transfer model CLOUD for reflection, transmission, and absorption characteristics of terrestrial clouds and discuss the accuracy of the approximations used within the model. A Fortran implementation of CLOUD is available for download. This model is fast, accurate, and capable of calculating multiple radiative characteristics of cloudy media including the spherical and plane albedo, reflection and transmission functions, absorptance as well as global and diffuse transmittance. The approximations are based on the asymptotic solutions of the radiative transfer equations valid at cloud optical thicknesses larger than 5.

While the analytic part of the solutions is treated in the code in an approximate way, the correspondent reflection function (RF) of a semi-infinite water cloud R_∞ is calculated using numerical solutions of the radiative transfer equation in the assumption of Deirmendjian's cloud C1 model. In the case of ice clouds, the fractal ice crystal model is used. The resulting values of R_∞ with respect to the viewing geometry are stored in a look-up table (LUT).

The results obtained are of importance for quick estimations of main radiative characteristics of clouds and also for the solution of inverse problems.

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