ELS-XV-2015 Abstracts
ELS-XV-2015-101
Electromagnetic & Light Scattering XV 2015, Leipzig

3D Monte Carlo simulation of solar radiance in the cloudy atmosphere applied to retrieval of aerosol and cloud characteristics from ground-based observations

T. B. Zhuravleva, T.V. Bedareva, and I.M. Nasrtdinov
V.E. Zuev Institute of Atmospheric Optics, SB RAS, Tomsk, Russian Federation (ztb@iao.ru)

As is well known, the spectral measurements of direct and diffuse solar radiation can be used to retrieve the optical and microphysical characteristics of atmospheric aerosol and clouds. Most methods of radiation calculations, which are used to solve the inverse problems, are implemented under the assumption of horizontal homogeneity of the atmosphere (clear-sky and overcast conditions). However, it is recognized that the 3D effects of clouds have a significant impact on the transfer of solar radiation in the atmosphere which can be the cause of errors in retrieval of aerosol and cloud properties.
We present the study results of angular structure of downward diffuse radiation in broken clouds (Bcld). To construct the cloud realizations, we use the model based on the Poisson point fluxes in space; clouds are approximated by inverted paraboloids. The simulation of radiative characteristics with specified spectral resolution is performed in spherical model of the atmosphere. The molecular absorption is taken into account on the basis of approximation of transmission function by short exponential series (k-distribution method).
The main factors that could significantly affect the transfer of solar radiation with the appearance of isolated cloud in the sky are considered. We analyze the sky brightness depending on the geometrical scheme sensing, illumination conditions, the cloud position with respect to the receiver and its optical and geometrical parameters. The presence / absence of cloud on the line of sight, its shading by cloud and reflected radiance impact on the Bcld variations, when the viewing angle is fixed. The presence of an isolated cloud may lead to significant increase or decrease of Bcld relative to clear sky atmosphere (tens of percent or more).
Due to the random nature of the cloud elements distribution in the space, the sky brightness in cloud fields varies from one to another cloud realization, depending on the configuration of the clouds. Effects of radiative interaction (mutual shading, multiple scattering between the clouds) occur in the broken clouds in addition to the 3D-effects of the isolated cloud. The regularities of angular structure of downward diffuse radiation in cloud fields for some typical cases (when the direction to the Sun and / or viewing direction are open / closed by clouds) are discussed.
The simulation results can be useful in the retrieval of the aerosol and cloud characteristics on the basis of radiation measurements in the solar almucantar, the principal plane and at the zenith direction, and also help improve the interpretation of the measured data in specific implementations.