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CLOUD MICROSTRUCTURE EFFECT ON THE LIDAR RETURN WITH MULTIPLE SCATTERING

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As known, multiple scattering contributes considerably into the lidar return from clouds. The usual way to calculate lidar signal with multiple scattering is Monte-Carlo simulation. We have recently developed semy analytical approach to calculate lidar return with multiple scattering, which relied upon the multicomponent method of solution of radiative transfer equation. In this approach the temporal dependence of the signal at the lidar receiver input is given in terms of optical parameters of cloud (extinction coefficient, single scattering albedo and phase function) and characteristics of a lidar system (field of view (FOV)of the receiver, angular divergence of the laser, lidar-cloud distance). The brief description of the model, method of solution and obtained results for different receiver FOVs and lidar-cloud distance are presented.

Next step is to link directly the lidar return signal with parameters of cloud microstructure. To do so we have developed new analytical solutions for cloud extinction and absorption coefficients and phase function. All the features of phase function including an aureole and glory are described through Bessel functions. Both the aureole and the glory are governed by the particle size distribution (PSD). We managed to describe them using the only cloud microstructure parameter, which is a ratio of the third to the second moment of the PSD.

Joint use of these two approaches provides the lidar return with multiple scattering in terms of the PSD parameters. The accuracy of obtained results estimated by comparison with Monte-Carlo data appears high enough.

The dependence of lidar return on microstructure parameters of clouds and lidar characteristics is presented. In particularly, it is shown an aureole and main mode of glory govern mainly the lidar signal up to optical depth about 5 for the typical lidar geometry parameters. Particularly, only the main mode of glory with the maximum at y=180 provides lidar return estimation with error no more than 6% and 12% at FOV less than 0.001 and 0.1, respectively. On the base of analysis of the sensitivity of lidar signal to medium characteristics, the possibility of cloud laser sounding and retrieval of the microstructure parameters are discussed.