Statistical simulation of laser pulse propagation through cirrus-cloudy atmosphere

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Lidar sounding is an effective tool for studying the optical and microphysical properties of scattering media. A wide range of inverse problems allowing us to obtain information about the properties of both atmospheric aerosol and clouds is currently being solved with the help of ground-based and space-borne lidars. The high sensitivity of lidars in detecting small aerosol impurities in the atmosphere, remoteness and high speed of data acquisition make them promising research tools. In this case, multiple scattering of radiation can play a significant role in the formation of lidar echo signals, which must be taken into account when interpreting the results of remote sensing. This issue requires careful study in view of the fact that many problems are solved using the single scattering approximation.

The phenomenon of multiple light scattering in the Earth's atmosphere is fully described by the radiative transfer equation, which has not yet been solved in its general form. The approximate methods are the most common techniques for solution of this equation. The present work proposes the original algorithms of the Monte Carlo method for simulating the propagation of laser pulses in the atmosphere taking into account high order scattering. The results of studying the features of pulse transfer and the formation of echo signals during remote sensing of a cloudy atmosphere are discussed. As clouds, cirrus cloudiness represented by a continuous homogeneous layer is considered. The capabilities of the original software developed for modeling lidar echo signals are briefly described. This work is supported by the Russian Science Foundation under grant No. 22-27-00719, https://rscf.ru/project/22-27-00719.