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Optical techniques of aerosol measurements and reliability problem

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This paper discusses the problem of the reliability with which the characteristics of the atmospheric aerosols are determined from the results of optical measurements (e.g. lidar, photoelectric measurements and measurements using transmissometers). It is a complex problem to develop optical techniques of aerosol measurements. Its solution involves taking into account a number of features of the apparatus and of the atmosphere.
It is no simple problem to obtain an adequate description of the characteristics of the atmosphere from lidar data. Two parameters of the atmosphere (backscattering coefficient and extinction coefficient) affect the amplitude of the backscattering signal and must be determined from one lidar equation. It is necessary to control the reliability with which the atmosphere parameters are determined from the lidar data. This has necessitated the development of new inversion techniques of multipositional lidar probing to increase the confidence in the results. Multiposition probing means measurements from various points of space by a movable lidar (or system of lidars) with a fixed distance between the radiation source and detector much less than the distance to the given scattering section of the atmosphere. An increased confidence level of the measurement results is attained by specifying applicability conditions for the inversion technique used. In particular, the relationship between the backscattering coefficient and extinction the coefficient can be found by solving lidar equation for various probing directions. The simulations of the errors were performed for multiposition schemes of lidar probing with realistic parameters of lidar and atmosphere.
The purpose of this paper is also to discuss the lidar equation solution developed for weak signal processing and the results of the effectiveness of these solutions.
The results of optical measurements can essentially depend on the optical properties of particles. So essential errors can take place in particle sizing using the optical techniques. The solution of the electromagnetic field differential equations is analysed to explain the experimental results. The model of spherical particle with the radially variable refractive index (with an optical inhomogeneous coating) is considered. Using of this model gives the possibility to explain the significant discrepancy found between the photoelectric and filter aspiration results.