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METHODS FOR ESTIMATING THE OPTICAL CONSTANTS OF ATMOSPHERIC HAZES BASED ON COMPLEX OPTICAL MEASUREMENTS

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The methods of multifrequency laser sounding (MLS) are the most effective remote methods for investigating the atmospheric aerosols, since they have made it possible to obtain complete information on aerosol microstructure and the effective methods for estimating the aerosol optical constants can be developed.

The MLS data interpretation consists in the solution of the set of equations containing those of laser sounding and equations for polydispersed optical characteristics. As a rule, the laser sounding equation is written in the approximation of single scattering and the equations for optical characteristics are written assuming that the atmospheric aerosol is formed by spherical and homogeneous particles.

The above assumptions correspond to the characteristics of atmospheric aerosol only in a certain approximation. However, an analysis of equations in this case is very useful, indicating the peculiarities of interpreting the MLS data in most general cases. Moreover, such analysis allows the development of general methods for interpretation of optical measurements on the basis of simple examples.

The above set of equations of the MLS method has two peculiarities. The first one is associated with the solution of incorrect inverse problems and is studied completely at present. The second one is typical for interpreting the optical measurements and is due to indeterminacy of equations relative to optical constants.

To remove the indeterminacy of equations the authors have suggested the method of optical sounding of atmospheric aerosol, consisting in a joint use of a multifrequency lidar and a spectral photometer in common geometrical scheme of the optical experiment. The method is used for investigating aerosols in the cases when absorption by particles is small and indicates the minimum necessary for interpretation of a series of measurements. The scheme is given in Fig.1. The spectral photometer 3, the light source 4 and the reflecting screen 5 are intended for measuring the scattering radiation coefficients within the atmospheric layer from the lidar 1 up to the scattering volume 2.

The basis of the method is the numerical solution of equation $f(m,\lambda) = \tilde{\beta}_{sc}(\lambda)$, where $\tilde{\beta}_{sc}(\lambda)$ is the value of the scattering coefficient measured with the photometer, and $f(m,\lambda)$ is a certain additional function calculated in the process of the MLS data interpretation. The function $f(m,\lambda)$ in the scheme of the MLS data inversion gives the predicted values of $\beta_{sc}(\lambda)$ with variable m. This function can be called conditio-

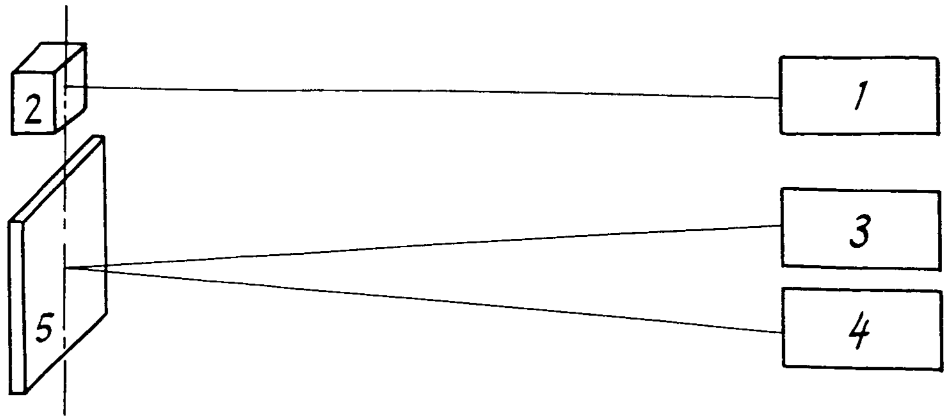

Fig.1. Scheme of the complex optical experiment on investigation of atmospheric aerosol parameters.

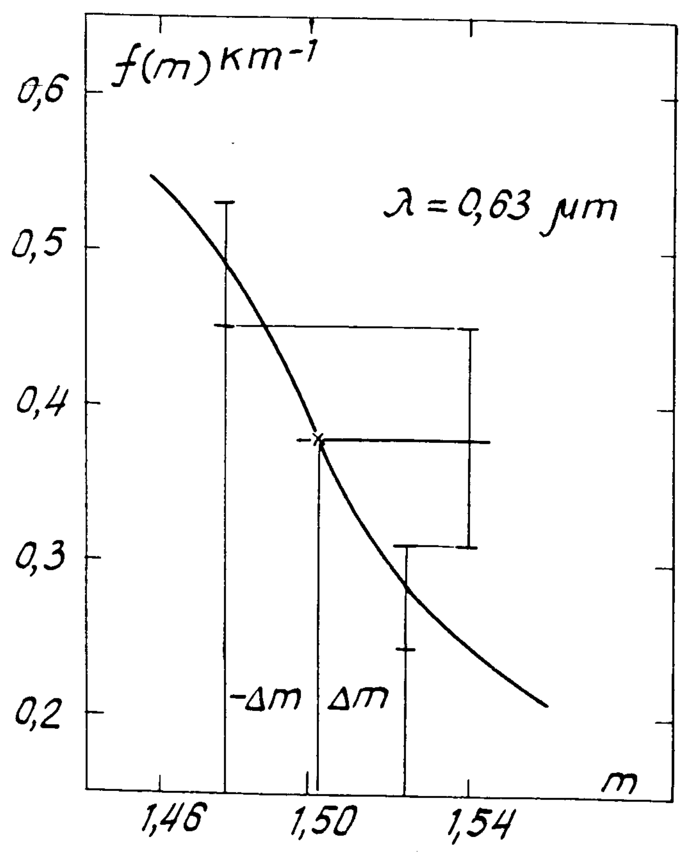

Fig.2. Example of determining m using the solution of equation $f(m, \lambda) = \tilde{\beta}_{3c}(\lambda)$ when interpreting the MLS data.

nally as a correction function, since it allows not only determination of optical constants but also calculation of the distribution function, representing more completely the aerosol microstructure.

An example of determination of optical constants using the above method is given in Fig.2. The correction function for the 0.63 μm wavelength was calculated while interpreting the data on three-frequency laser sounding (λ = 0.53, 0.69 and 1.06 μm). The value of the extinction coefficient measured with the photometer (straight line) allows the determination of $m \simeq 1.50$. If the lidar measurements are made with an error ± 10% and the photometer measurements error is ± 20%, then, as follows from the figure, the error Δm in the determination of optical constants is equal to ± 0.025. The decrease of the photometric measurements error up to ± 10% results in $\Delta m = \pm 0.012$.

The method developed by the authors was used when sounding the surface aerosol. The obtained values of optical components and the data on aerosol microstructure for a number of measurements are in agreement with the results of direct measurements.