JOINT SOUNDING OF THE ATMOSPHERE WITH THE AIRBORNE AND GROUND LIDARS

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ABSTRACT

The lidar equation written in the single scattering approximation is dependent on two variable parameters, i.e., the volume coefficients of attenuation (scattering) α and backscattering σ_π. It is impossible to solve the lidar equation without superposition of some a priori information on α or σ_π; as a rule the feasibility of equation $\sigma_\pi = b\alpha$ is assumed. The values of b can undergo variations against concrete conditions. In the case when the backscattering coefficient profile $\sigma_\pi(z)$ is known, from the lidar equation

$$F(z) = A\sigma_\pi(z)\, z^{-2} \exp\left[-2\int_0^z \alpha(\xi)\, d\xi\right] \qquad (1)$$

one can obtain the values of the scattering differential coefficient

$$\alpha(z) = \frac{1}{2\varphi(z)} \cdot \frac{d[\varphi(z)]}{dz}, \qquad \varphi(z) = \frac{F(z) z^2}{A\sigma_\pi(z)} \qquad (2)$$

While sounding the atmosphere at small distances along the horizontal route the backscattering coefficient can be defined from Eq.(1)

$$\sigma_\pi = \frac{z_1^2 \cdot z_2^2}{z_2^2 - z_1^2}\left[F(z_1) - F(z_2)\right] \qquad (3)$$

In the described experiment an airborne lidar developed specifically was used for horizontal sounding of the atmosphere. In the course of spiral gain or decrease of the flight altitude we could determine the values of $\sigma_\pi(z)$ with a constant accuracy. A ground lidar, placed on the polygon of the Institute of Atmospheric Optics, sounded the atmosphere vertically inside the airplane spiral. The lidar permitted the definite layers to be quickly separated out and the airplane to be directed into those for further joint measurements, from which the values of lidar ratio $\beta = \sigma_\pi / \alpha$ were estimated. During independent flights the value distribution of the backscattering coefficient in horizontal and vertical directions was investigated in conditions of West-Siberian Lowland.

According to the results of the experiments it should be noted that the atmosphere at the altitudes of more than 1500 m is more homogeneous horizontally than in lower layers; over large tracts of forest it is more homogeneous than over town; an exponential decrease of the scattering coefficient up to the altitudes of 5000m was not observed; the lidar ratio is variable, but under conditions of stable meteorological situation the variations of the latter decrease.