VARIATIONS OF THE SCATTERING INDICATRIX FOR RANGING ANGLES θ = 120-180°

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One of the important problems in laser sounding of atmospheric aerosol is the choice of the scattering indicatrix of the light, normalized with respect to the volume scattering coefficient in the direction of the receiving device. As a rule, these are scattering angles close to 180°. The purpose of the present study was to analyze the variations of the normalized scattering indicatrices in the scattering-angle region θ = 120-180°, in order to separate the scattering angles where these variations are minimal, i.e., where the connection between the indicatrix and the volume scattering coefficient is closest to linear. We analyzed 41 groups of calculated normalized scattering indicatrices of light by polydispersed systems of spherical nonabsorbing particles. The groups considered included the Junge models [1, 2], gamma distributions [2-4], and normal-logarithmic distributions [5]. For each group of models we calculated the average normalized scattering indicatrices of the light $\bar{\ell}(\theta_K)$ and their variation coefficients $\Delta(\theta_K)$.

For convenience in presenting the results of the analysis, all the considered groups of models can be arbitrarily divided into two types: hazes and clouds (fogs). Hazes were taken to be distributions of the Junge type [1, 2], "broad" single-vertex distributions — Deirmenjian hazes (configurated gamma distribution) [3], and normally logarithmic distributions [5] with variance of the logarithms of the particle radii σ^2 = 0.5. Clouds (fogs) included groups of Deirmenjian clouds [3], gamma distributions [2, 4], and normal-logarithmic distributions (σ^2 = 0.01-0.1). As a result of the analysis, one can draw the following conclusions (the details of the analysis results are given in [6]).

1. Most average normalized indicatrices are close in value at $\theta \approx$ 150°, and their variation coefficients have minima in the region of scattering angles θ = 140-160°. This makes it possible to estimate approximately the bulk-scattering coefficient from measurements of the scattering indicatrix for $\theta \approx$ 150°.

2. In the case of concrete aerosol formations, an estimate of the bulk-scattering coefficient can be obtained from the scattering of the light into a fixed angle as a function of the refractive index of the aerosol m and of the "width" of the distribution. Namely:

a) hazes: m = 1.33, observations at $\theta \approx$ 155°, $\bar{\ell}$(155°) = 0.01-0.015; m = 1.5, observations at $\theta \approx$ 157°, $\bar{\ell}$(157°) = 0.022-0.026;

b) clouds (fogs): m = 1.33, observations at θ = 140-145°, $\bar{\ell}$(140°) = 0.02-0.03; m = 1.5, observations at θ = 160-165°, $\bar{\ell}$(165°) = 0.045-0.055.

3. From the point of view of the minimum coefficient of the variations of the average normalized indicatrix, backscattering is best used when sounding aerosol formations with single-top distribution of the number of particles in size and with a "width" typical of clouds (fogs): $\bar{\ell}$(180°) = 0.032-0.054 (m = 1.33) and $\bar{\ell}$(180°) = 0.058-0.070 (m = 1.5). For "broad" distributions (haze) the scatter of the values at $\bar{\ell}$(180°) is larger: $\bar{\ell}$(180°) = 0.013-0.040 (m = 1.33) and $\bar{\ell}$(180°) = 0.038-0.076 (m = 1.5). It must be noted that the minimum of the variation coefficient is typical only of models of the Junge type, while for

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the remaining models of the hazes the connection between the scattering indicatrix at angles θ = 155-157° with the bulk scattering coefficient is closer to linear than for the backscattering indicatrix.

4. There are grounds for assuming that the position of the minimum of $\Delta(\theta)$ depends on the refractive index. This can permit, in principle, the refractive index to be estimated from the position of the minimum of the coefficient of variation $\bar{\delta}(\theta)$ in the scattering angle range θ = 120-180°C.

The results of the work as a whole agree with the experimental and calculated data of [7-10].

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