FEATURES OF DIURNAL VARIATION OF THE VERTICAL PROFILES OF AEROSOL SCATTERING IN A ROLLING TERRAIN

Yu. P. Dyabin, A. N. Alekseev, and V. V. Balakirev

Investigations of the irregularities of formation and transformation of the vertical structure of aerosol scattering as a function of various weather and climatic conditions is at present a timely problem of atmospheric optics. Such knowledge is necessary for a successful solution of problems connected with contamination of atmospheric air, connected with sources and sinks for aerosols, and also important for the construction of detailed optical models of the atmosphere.

This paper contains the results of optical sounding of the behavior of the atmosphere in the period from 30 July to 20 September, 1981, under conditions of mountain and valley topography. The data obtained with the aid of an optical locator, the energy parameters of which were analogous to the apparatus described in [1], were reduced by a combined procedure [2] in order to reconstruct the altitude dependence of the aerosol backscattering coefficient $\sigma_\pi(H) = \sigma_p(H) \cdot \beta_\pi(H)$ ($\sigma_p(H)$ is the aerosol scattering coefficient at altitude H, $\beta_\pi(H)$ is the value of the scattering indicatrix in the backward direction). Under conditions of a weakly turbid atmosphere, the error in the reconstruction of the profiles $\sigma_\pi(H)$ was about 30% [3]. The atmosphere was sounded in intervals of 1-2 h predominantly in daily series, and a number of meteorological parameters in the surface layer were monitored and data of radiosounding of vertical profiles of the temperature, humidity, and wind velocity and direction were monitored at the same time.

An analysis of the results has shown that a single-valued diurnal variation of the quantity $\sigma_\pi(H)$ is observed in the indicated region, and is characterized by large variations in the layer next to the earth (Fig. 1).

With increasing height above the underlying surface, the variations of the diurnal course of $\sigma_\pi(H)$ become negligible. It must be noted that the increase of σ_π in the evening (20-22 h) is observed only in the layer about 0-0.4 km. The morning maximum at 11-12 a.m. local time

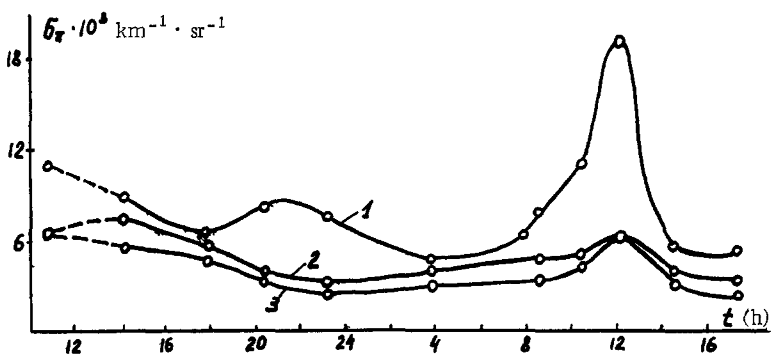

Fig. 1. Diurnal course of σ_π at different heights H, obtained 7-8 September, 1981: 1) $H = 0$, 2) 0.5, 3) 1.0 km.

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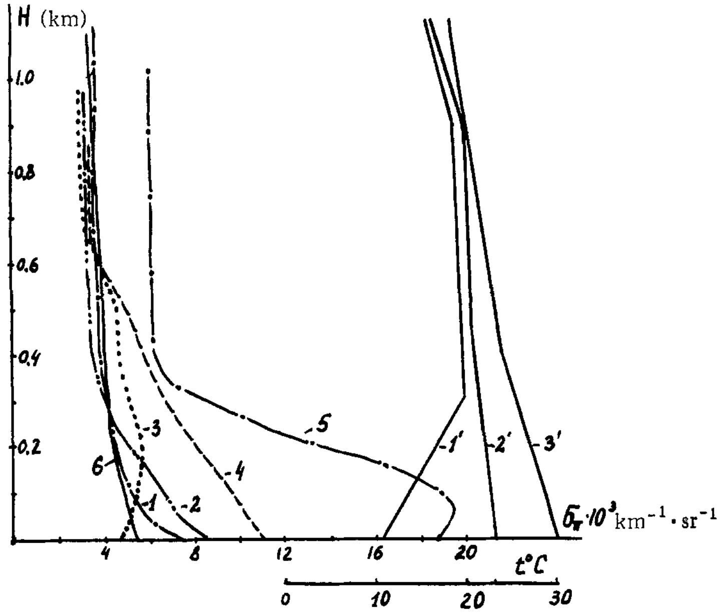

Fig. 2. Vertical profiles of $\sigma_\pi(H)$ (1-5) and of the temperature (1'-3') obtained on 7-8 September, 1981. Sound time for profiles: 1) 20 h 20 min; 2) 23 h 10 min; 3) 3 h 50 min; 4) 10 h 30 min; 5) 12 h 00 min; 1') 3 h 00 min; 2') 9 h 00 min; 3') 15 h 00 min; 6) 14 h 30 min.

appears at heights about 1 km, but to a lesser degree compared with the layer next to the earth. The comparison of the vertical profiles of the temperature and of the backscattering (Fig. 2) allows us to assume that formation of the morning maximum of σ_π is primarily the result of accumulation of impurities (aerosols) under the nighttime surface inversion layer. It follows from Fig. 2 that the largest values of σ_π are reached in the surface layer at the earth in noontime. Next, as a result of intense turbulent mixing, the profile of $\sigma_\pi(H)$ becomes equalized in the layer 0-1 km, within a time of the order of 2-3 h. The described mechanism of formation and transformation of the vertical profiles of $\sigma_\pi(H)$ agrees well with earlier [4] results of numerical simulation of scattering of impurities in the boundary layer of the atmosphere and does not contradict the three-layer model of the aerosol attenuation coefficient typical of the warm season of the year [5, 6].

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EFFECT OF HUMIDITY ON THE SCATTERING INDICATRIX OF HAZE NEAR THE EARTH'S SURFACE IN THE REGION OF RANGING ANGLES

A. R. Nasyrov and V. L. Filippov

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The investigation of the scattering indicatrices of the atmosphere in the region of scattering angles $\theta \sim 180°$ is of interest from the point of view of the interpretation of the results of optical sounding of the atmosphere, the solution of the inverse problems of atmospheric optics, and a number of other applications.

In the presented paper are given the results of experimental investigation of the scattering indicatrices $\varkappa(\theta)$ of haze next to the earth in the angle region $\theta \simeq 178°$ for the wavelength $\lambda \sim 1.1$ μm.

The apparatus for measurement of the coefficient of the directional light scattering $\beta(\theta)$ and the procedure of its calibration and of the measurements are analogous to those described in [1]. The measurements were performed under conditions of haze during twilight and nighttime in May-October, 1979-1980. Simultaneously with the measurements of $\beta(\theta)$, a base method was used to determine the volume coefficient of attenuation of the atmosphere $\alpha(\lambda)$ at wavelengths 0.63 and 1.1 μm and also the relative humidity f of the air. The meteorological visibility S_M varied in this case in the range from 3 to 20 km, with f in the range from 55 to 98%.

To determine the dependence of the absolute scattering indicatrix $\varkappa(178°)$ on humidity f its values were defined as $\varkappa(178°) = \beta(178°)/\alpha(\lambda)$ and averaged over all the realizations for the following ranges of f: 50-60, 60-70, 70-80, 80-87, 87-93, and 93-98%.

The results of such an averaging (see Fig. 1) with an error not larger than 10% are approximated by the function

$$\varkappa_{\pi}(f)_c = \begin{cases} 1{,}5 \cdot 10^{-2} & \text{for } f \leq 90\%, \\ [1{,}5 + 0{,}3(f - 90\%)] \cdot 10^{-2} & \text{for } f > 90\%. \end{cases}$$

The limits of the variations of $\varkappa_{\pi}(f)$ from the mean value $\varkappa_{\pi}(f)_c$ for all the considered ranges of f do not exceed ±40% and are shown in Fig. 1 in the form of vertical lines.

The values obtained at $f \leq 90\%$ agree satisfactorily with the most probable values $\varkappa(180°)$ in the visible part of the spectrum for the Black Sea shore and for deserts in accordance with the data of [2], respectively, 0.02 and 0.015.

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