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Abstract

Full Text

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AN AEROSOL LAYER IN THE UPPER ATMOSPHERE

(Presented by Academician E. K. Fedorov, 4 IX 1961)

It is known that the brightness of the sky in the upper atmosphere is made up of the intrinsic glow of the atmosphere and scattered light. Under daytime conditions, the intrinsic glow of the atmosphere makes only an insignificant contribution to the total brightness of the sky, which is due mainly to the effect of scattering by gas molecules and by aerosol particles present in the atmosphere.

Studies of the brightness of the upper atmosphere can be carried out both by indirect measurements (the twilight method) and by direct ones (vertical sounding of the atmosphere with the aid of balloon-sondes and rockets).

The study of the brightness of the daytime sky by means of rockets began in 1946; photometers and photocameras were used for this purpose. The results obtained give contradictory data on the brightness of the light of the daytime sky ([1–3]).

Fig. 1. I –northern latitudes, II –middle latitudes

The brightness of the daytime sky was studied by us at different altitudes with the aid of a photoelectric photometer. The instruments had a sensitivity of $\sim 0.5 \cdot 10^{-8}$ stilb for integral light and $1.5 \cdot 10^{-10}$ $\mathrm{W/cm^2} \cdot \mathrm{ster} \cdot \mu$ for individual wavelengths. The introduction of attenuators into the circuit made it possible to obtain a range of measured brightnesses from $0.5 \cdot 10^{-8}$ to $0.5 \cdot 10^{-5}$ stilb.

To determine the brightness of the upper atmosphere, several experiments were carried out. The results of processing the first experimental data obtained are shown in Fig. 1. The curves show that in middle latitudes the brightness of the sky is higher than in northern latitudes. This can be explained only by a larger number of scattering particles.

From the measured values of sky brightness at individual wavelengths, it is easy to calculate the optical thickness and, consequently, both the Rayleigh and the

Fig. 2

Figure 2: Fig. 2

aerosol scattering coefficients. For this it is sufficient to measure the intensity of the scattered light at two wavelengths or at two different scattering angles. The problem is simplified still further if, in determining the coefficient of Rayleigh scattering, one makes use of data available in the literature on the composition and density of the upper atmosphere. Then the optical thickness due to the aerosol component of the atmosphere, one-

is determined reliably from direct measurements of the brightness of the sky at some one wavelength.

To determine the amount of aerosol in some layer of the atmosphere, it is apparently necessary to have measurements of the brightness of scattered light at the upper and lower boundaries of the layer; then the aerosol optical thickness of the layer will be equal to the difference

$$\tau_{\text{aer.layer}} = \tau_{\text{aer }(h+\Delta h)} - \tau_{\text{aer } h},$$

whence, taking $\tau_{\text{aer.layer}} = k(\rho)\pi r^2 N \Delta h$, where N is the number of particles in 1 cm^3, r is the mean radius of the scattering particle, and $k(\rho)$ is the Stratton-Houghton coefficient, one can determine the value of the coefficient of aerosol scattering β_{aer}.

Fig. 2. $I - \beta_{\text{aer}}$ for northern latitudes; $II - \beta_{\text{aer}}$ for middle latitudes; $III - \beta_{\text{rel}}$

Figure 2 gives the values of the coefficient of Rayleigh scattering β_{rel} and aerosol scattering β_{aer} as a function of altitude for the middle and northern latitudes of the USSR; these show that in the middle latitudes the aerosol content at altitudes from 80 to 100 km is considerably greater than in northern latitudes. Moreover, both in northern latitudes and in middle latitudes β_{aer} has a maximum: in northern latitudes at an altitude of 92 km, and in middle latitudes at an altitude of 85 km. Thus the curves show that around the Earth at an altitude of 80 km and above there is an aerosol layer with β_{aer} of the order of 5 to $20 \cdot 10^{-12}$ cm^{-1}. At an altitude of 100 km, i.e., above the maximum of the layer, β_{aer} is still several times greater than β_{rel}. This indicates that the layer continues to exist above 100 km as well.

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Note: Figure translations are in progress. See original paper for figures.