PRELIMINARY RESULTS OF EXPERIMENTAL INVESTIGATIONS OF SPECTRAL SKY BRIGHTNESS IN THE UV SPECTRAL RANGE

S.I. Dolgii, V.V. Zuev, V.A. Kazyurin, V.N. Marichev, and A.I. Petrov

Institute of Atmospheric Optics,
Siberian Branch of the Russian Academy of Sciences, Tomsk
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The paper presents the first results of vertical observations of the spectral sky brightness in the 280–320 nm *range. It is shown that the optical thickness* τ *in the* 300–310 nm *range correlates with the total ozone content X for measurements carried out at the same solar elevation angles. However, to obtain the unambiguous relationship between* τ *and X at different solar elevation angles it is necessary to develop in more detail the technique for taking into account the molecular and aerosol scattering and the absorption by ozone. In some specific cases the anomalous behavior of the sky brightness has been revealed in the* 300–310 nm *and* 310–320 nm *ranges before and after the Sun's culmination.*

Investigations of the incoming solar radiation in the 280–320 nm UV spectral range is important from the standpoint of its biological and radiative effects. The first is caused by erithematous and bactericidal efficiency that can positively or negatively affect a body depending on the exposure dose. The second is caused by noticeable contribution of the radiation in this spectral range to the total incident solar radiation that forms the Earth's climate as a whole. In passing through the Earth's atmosphere, the solar radiation attenuates due to the scattering on aerosol formations (aerosols and clouds) and molecules of air and due to the absorption by ozone, especially in the stratospheric ozone layer. The incoming solar radiation changes depending on the variations of the optical thicknesses of the above–enumerated components. Thus, from an analysis of the data on the spectral atmospheric transparency, one would obtain the quantitative characteristics of aerosol and ozone, in particular, the aerosol spectral optical thickness and the total ozone content.

In this paper we analyze the data of vertical observations of the spectral brightness of daytime sky in the 280–320 nm UV range. The field–of–view angle of observations did not exceed $7.5\cdot10^{-3}\times5\cdot10^{-4}$ sr. Radiation from a vertical atmospheric column was directed to a mirror telescope with a diameter of 30 cm and a focus of 2 m by a flat mirror. Optical axis and focal plane of the telescope were aligned with those of the input slit of the MDP–23 monochromator included in the KSVU–23 measurement complex. The spectral resolution varied depending on the sky brightness in the 0.08–0.26 nm range, the time of recording of individual spectrum was 1.5 min. Measurements were carried out in the daytime and were accompanyed with recording of the time of measurements, from which the solar elevation angle was determined. The spectra obtained in cloudless days from July 14 to September 6, 1994 from 9 a.m. to 8 p.m., LT were selected for an analysis. The results of experimental data processing were compared with measurements of the total ozone content carried out during the same period by means of the M–124 ozonometer as well as with measurements of the illumination in the focal plane of the receiving telescope performed by a luxmeter.

The typical brightness spectra obtained on June 29, 1994 at 2 p.m. and 8 p.m., LT (solar elevation angles were 56.5° and 22.4°, respectively) with 0.1 and 0.13 nm resolution are shown in Fig. 1. It is seen that the UV radiation with wavelength $\lambda > 300$ nm reaches the Earth's surface. The comparison of the illumination E measured by the luxmeter in the 400–700 nm spectral range with the integral sky brightness I in the 310–320 nm wavelength range is shown in Fig. 2. Since the attenuation of radiation in these spectral ranges is predominantly nonselective (absorption by ozone, water vapor, and nitrogen oxide is insignificant) and is caused by molecular and aerosol scattering, as is seen from Fig. 2, the curves are highly correlated one with another. The correlation coefficient calculated from 53 pairs of points was equal to 0.74.

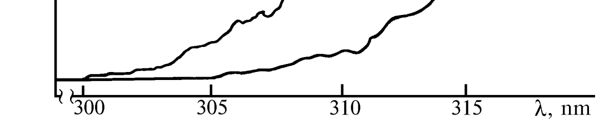

FIG. 1. Spectral brightness obtained at different solar elevation angles.

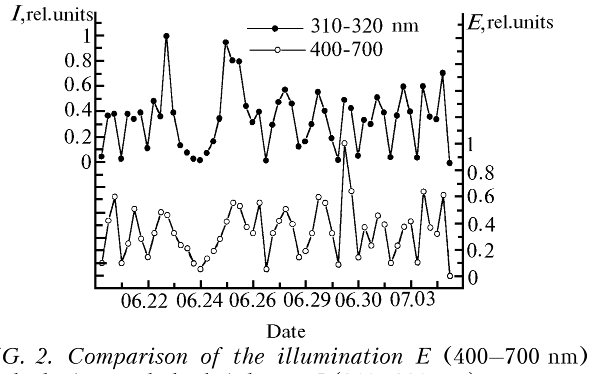

FIG. 2. Comparison of the illumination E (400–700 nm) *with the integral sky brightness I* (310–320 nm).

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The optical thicknesses caused by the absorption of atmospheric ozone were calculated by the formula

$$\tau = \sin\theta \times \ln(I_2 / I_1), \qquad (1)$$

where θ is the solar elevation angle, I_1 and I_2 are the integral brightness in the 300–310 and 310–320 nm wavelength ranges, respectively. The quantity I_2 was selected as a reference signal for taking into account the light scattering.

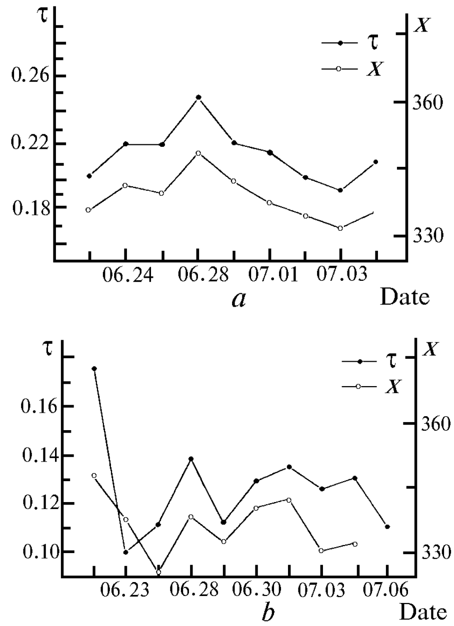

FIG. 3. Optical thicknesses τ measured at 10 a.m. *(a) and* 2 p.m. *(b), LT in comparison with the total ozone content X.*

Optical thicknesses obtained about 10 a.m. and 2 p.m., LT (θ = 33–35° and 55–56.5°) are shown in Fig. 3 along with the temporal behavior of the total ozone content X in Dobson units. The identical behavior of τ and X is revealed that indicates the applicability of the brightness measurements in the 300–310 nm ranges to observation of the total ozone content. In addition, an effort to generalize all the data obtained at different solar elevation angles and to find the simple relationship between τ and X has not met with success. In particular, the optical thickness τ reached its maximum values in the morning and in the evening, and went through minimum at the Sun culmination moment. This fact cannot be explained by variations of X, because the values of τ varied up to 100%, whereas the values of X varied by no more than 8%. Evidently, the conditions of formation of the light-scattering signal within the observation cone and its partial absorption by atmospheric ozone have an effect in this case. Consideration of these factors requires more developed technique for light signal processing depending on the solar elevation angle, as well as allowance for the aerosol and ozone content in the atmosphere.

In conclusion, Fig. 4 shows the plots of the sky brightness measurements during two days depending on the solar elevation angle. By comparing the leftward and rightward branches of the spectral brightness obtained in the 300–310 and 310–320 nm ranges before and after the Sun culmination, we can establish the following. Anomalous behavior of the sky brightness was observed on June 28, 1994 (Fig. 4*a*) before and after the Sun culmination, i.e., for the same elevation angles θ the sky brightness in the afternoon was greater than that before noon. However, in the next day, on June 29, 1994 (Fig. 4*b*) the behavior of the integral brightness in the 310–320 nm range before and after culmination was practically identical.

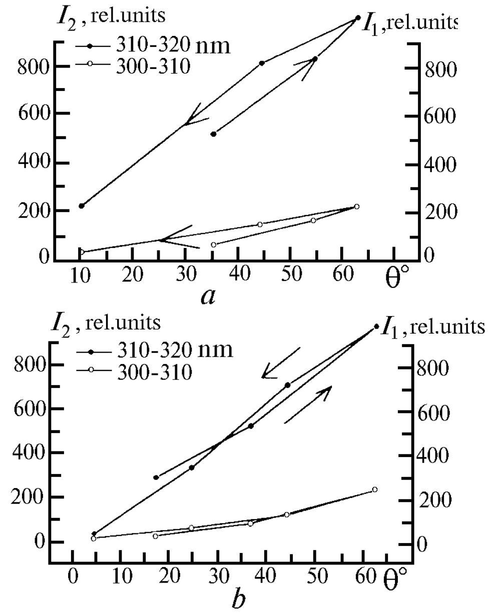

FIG. 4. Daytime measurement of the sky brightness depending on the solar elevation angle θ□: a) June 28, 1994 and b) June 29, 1994.

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