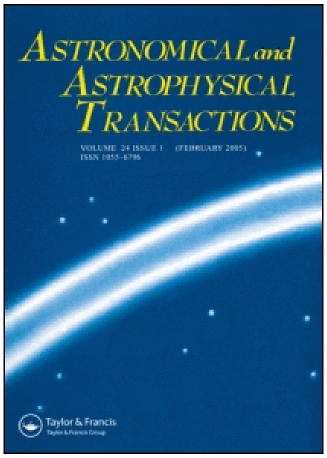

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V. N. Glushko [a]; L. A. Egorova [a]; P. G. Lysenko [a]
[a] Fesenkov Astrophysical Institute, Almaty, Kazakhstan

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Optical thicknesses of extinction of the cloudless atmosphere in the region of the Fesenkov Astrophysical Institute from 1996 to 2004

V. N. GLUSHKO, L. A. EGOROVA* and P. G. LYSENKO

Fesenkov Astrophysical Institute, 050020 Almaty, Kazakhstan

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In this paper the data obtained from monitoring the optical thickness of extinction during the months of August and September for the period from 1996 to 2004 in the spectral region 0.42–1.28 μm are analysed.

Keywords: Atmospheric optics; Atmospheric extinction

Investigations on the optical parameters of the atmosphere at various points of the globe have been of great importance up to now. Space research on the terrestrial surface obtained from satellites, ecology and climatology, and not full scientific data where it is necessary to know the optical characteristics of the atmosphere during specific moments of time at a specific place, has been essential. Thus it is not always possible to use the global models of atmosphere developed by the World Meteorological Organization, because of significant spatial and time variations in the properties of the atmosphere.

From the early 1970s, rather regular complex measurements of the optical characteristics of the cloudless atmosphere (including the optical thicknesses of extinction) in a wide spectral region with the help of a day-sky filter photometer [1] have been carried out at the Fesenkov Astrophysical Institute. The territory of the Observatory where the measurements were basically made is located 12 km to the south of Almaty in the Zailijsky Alatau foothills at a height of 1350 m above sea level in the active zone of mountain–valley breezes; so, for the optical thicknesses measured in clear cloudless anticyclone weather during the early morning time (up to 9–10 o'clock local time), it is possible to measure transparency values approaching the background value for a given place.

The optical thicknesses τ of extinction were calculated basically by the 'long' Bougouer–Langley method with obligatory control of the stability of the optical properties of the atmosphere. Also, for each moment of observation, the τ values were calculated by the 'short' method of extra-atmospheric illumination (from values of the direct solar radiation) [1]. The results of monitoring the quantities τ for the period from 1971 to 1997 have been analysed

*Corresponding author. Email: adm@aphi.kz

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earlier [2, 3]. In [2, 3] it was shown that for 1971 and the early 1980s the optical thicknesses had minimal values and changed rather insignificantly; these proved to confirm the literature data [4, 5], according to which the periods 1972–1974 and 1977–1979 are considered as the background values. In 1983–1984, the τ values increased by tens of a per cent. Probably, this decrease in the transparency of the atmosphere echoes the increased volcanic activity in the early 1980s. In 1996–1997, the transparency of the atmosphere improved up to the background values of the 1970s. This tendency correlated both with a post-volcanic relaxation and with the downturn in the level of economic activities in the territory of the former USSR in those years [6].

In this paper the data obtained from monitoring the optical thickness τ of extinction during August and September for the period from 1996 to 2004 in the spectral region 0.42–1.28 μm are analysed. In table 1, the quantities τ, their root-mean-square deviations σ and the variations Δ (in per cent) for each year of the measurements are given. The data on the measurements for 1996 are shown in the table only for comparison because, in that year, observations were carried out in a valley at a height of 900 m above sea level.

The analysis of the results in table 1 shows that, for the years investigated, the variations in the optical thickness of extinction were rather small, and in absolute values they were almost equal to or even, for some data, smaller than the data in 1971. In our district it is possible to explain this apparent improvement in the transparency of the atmosphere not only by the above-mentioned factors but also by anomalies in the weather changes that took place

Table 1. Optical thickness of extinction (τ) for the period 1996–2004 (antemeridian values).

Year	λ, μm	0.421	0.478	0.540	0.667	0.796	1.28
1996	τ	0.382	0.272	0.208	0.124	0.091	0.078
	σ	0.049	0.048	0.037	0.031	0.026	0.023
	Δ	12.9	17.6	17.7	25.4	28.6	29.0
	N	23	24	24	24	24	24
1997	τ	0.365	0.260	0.189	0.112	0.080	0.067
	σ	0.038	0.031	0.028	0.026	0.022	0.021
	Δ	10.5	12.4	14.7	20.0	27.0	31.6
	N	11	11	12	11	10	12
1998	τ	0.353	0.250	0.189	0.111	0.076	0.063
	σ	0.047	0.037	0.031	0.022	0.020	0.019
	Δ	13.3	14.9	16.4	19.8	25.7	29.9
	N	17	19	18	18	16	16
2001	τ	0.366	0.253	0.195	0.114	0.083	0.064
	σ	0.036	0.034	0.032	0.025	0.018	0.019
	Δ	9.9	13.6	16.5	21.8	22.2	27.7
	N	10	10	10	10	10	10
2002	τ	0.396	0.286	0.214	0.128	0.091	0.072
	σ	0.059	0.046	0.042	0.027	0.030	0.026
	Δ	14.9	16.0	19.8	20.9	33.0	36.9
	N	7	7	6	7	7	7
2003	τ	0.364	0.259	0.193	0.113	0.078	0.060
	σ	0.031	0.027	0.023	0.014	0.0130	0.008
	Δ	8.64	10.5	12.0	12.7	17.3	13.2
	N	13	13	13	13	13	13
2004	τ	0.360	0.258	0.199	0.122	0.083	0.060
	σ	0.047	0.039	0.042	0.036	0.041	0.030
	Δ	13.0	15.2	21.3	29.1	49.0	52.2
	N	7	7	7	7	7	7
Average	τ	0.364	0.256	0.194	0.115	0.081	0.065
	σ	0.042	0.035	0.031	0.023	0.022	0.020
	Δ	11.5	13.4	16.1	20.4	27.6	30.7
	N	65	66	66	66	63	65

Table 2. Result on years the number of days of observations in August and September (N), number of days for which it was possible to use Buger-Lengley method (Nb), and number of days with rains (No).

Year	N	Nb	No
1997	56	18	1
1998	28	15	11
2001	16	10	4
2002[a]	19	4	–
2003	49	13	16
2004	33	7	17

[a]Only August.

in the Almaty region, namely during the summer and autumn months (the basic period of observations) for the last few years the number of deposits that washed away aerosols from the atmosphere has increased, which probably led to the downturn in background values. On the other hand, the weather changes that occurred every year are that the number of days with clear cloudless weather and with optical stability decreased. These conclusions are well proved by the data in table 2.

With respect to this, it is interesting to compare histograms of the distributions of the spectral optical thicknesses calculated by the method of 'extra-atmospheric illumination' for observations in 1997 and 2003. In figure 1, histograms of the distributions of τ for wavelengths

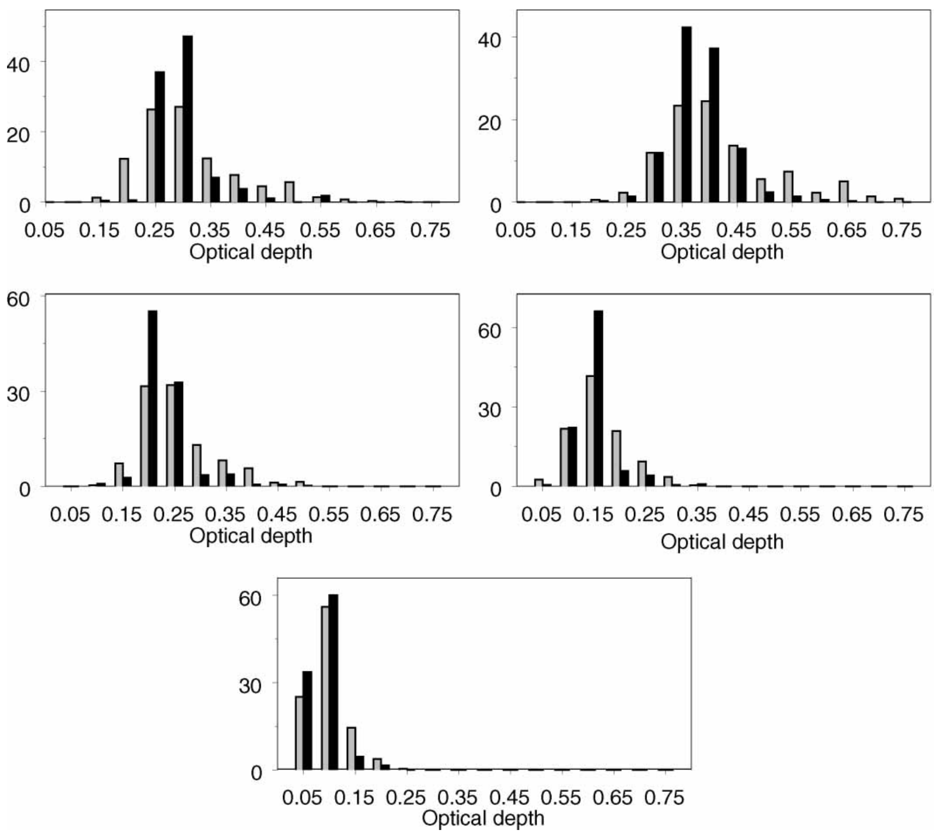

Figure 1. Histograms of the distribution of τ for various wavelengths: (a) 0.421 μm; (b) 0.478 μm; (c) 0.540 μm; (d) 0.667 μm; (e) 1.28 μm. Data for 1997 are shown in grey and those for 2003 in black.

of 0.421, 0.478, 0.540, 0.667 and 1.28 μm are shown. The interval $\Delta\tau$ (on the abscissa axis) is plotted against the number N of cases for every percentage interval of total realizations (on the ordinate axis); in 1999, N was approximately equal to 1000 and, in 2003, $N = 370$. The average values of τ calculated by the Bougouer–Langley method for these years are almost equal, while the number of deposits in these years differ sharply from each other. It is possible to assume that a substantial increase in the amount of rainfall in 2003 affected the form of the distribution of τ values which has a more well-defined maximum at all wavelengths and narrower deviation in the absolute values.

In conclusion we note that, from the results of measurements on the spectral optical thickness of extinction in the Almaty area during the last 9 years, no appreciable tendencies in the change in the background values τ have been revealed. Within the limits of measurement errors the τ values coincide and are the most minimal for all years in which observations have been made.

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