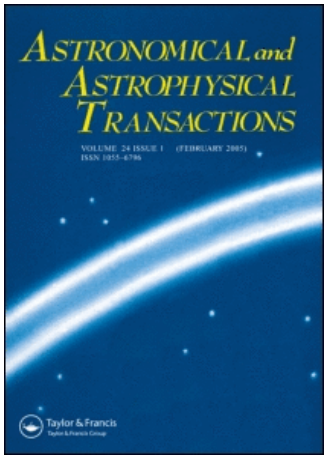

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The equipment set-up and measurements of the optical parameters of the urban haze of Almaty during the autumn-winter period in conditions of a cloudless atmosphere

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The equipment set-up and measurements of the optical parameters of the urban haze of Almaty during the autumn–winter period in conditions of a cloudless atmosphere

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The equipment set-up for measuring the optical parameters of an urban haze is described. Some results of the investigations on the urban haze in Almaty city from observations of the daytime cloudless sky in the city centre and outside the region of urban pollution are given.

Keywords: Urban haze; Aerosol pollution of the atmosphere

Investigations of the aerosol pollution of the atmosphere in different cities and with various types of equipment set-up have been carried out for a long time. Optical research methods are more interesting because of the low cost and the possibility that the natural aerosol particles moving in the air are not changed.

In the 1970s and 1980s, complex investigations on urban aerosol pollution were carried out. Many scientific groups equipped with modern instruments, lasers, sonars and planes took part in these investigations. Among these studies were the Los Angeles experiment in Pasadena, the 'KENEKS' experiments in different cities of the former USSR, and the 'ANZAG' experiment in Almaty city in 1987. Now this problem of aerosol pollution continues to be of great interest [1, 2].

For many years the optical properties of the background and urban aerosols both for the whole atmospheric column and for the terrestrial layer have been studied in the Department of Atmospheric Optics of the Fesenkov Astrophysical Institute [3, 4]. The greatest concentration of urban pollution in Almaty is observed in the autumn–winter period when cloudless windless weather occurs. Such weather causes the appearance of a dense haze layer with a sharp high boundary. This haze layer has a colour from light grey to almost black. Usually the boundary of the haze layer is below the Observatory level until noon (the difference between the heights of the city centre and the Observatory is approximately 700 m).

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In this connection, it was planned to carry out an experiment on simultaneous measurements of the optical parameters of the atmosphere at these two levels and, on the basis of these measurement data, to obtain the optical characteristics of the layer. For this purpose an apparatus set-up consisting of two filter photometers and made at the Astrophysical Institute was used. The optical part of each photometer consisted of a lens objective, a cassette with six filters for the spectral interval 0.42–2.16 μm, two cartridges with polaroids (separately for the visible and infrared spectral ranges), a breechblock, an obturating device and a photodetector. Beside each photometer was a special device for measurement of the natural illumination on a horizontal platform by direct and scattered solar radiation. The electronic part included a narrow-band alternating-current amplifier, a linear rectifier and a recorder.

As a result of the measurements which were carried out simultaneously at two levels, sets of the following parameters were obtained: the optical thicknesses τ of extinction; the brightness indices $\mu(\phi)$; the degrees of polarization of scattered light; the natural illumination E_λ of a horizontal platform by direct and scattered sunlight.

The primary observations were carried out in October–November 1981. On the basis of these observations, it was possible to estimate the absorbing ability of urban aerosols and to separate two types of haze, namely 'bluish-grey' and 'black', by observations of the haze colours from the Observatory. In the 'bluish-grey' haze the contribution of the optical thickness of absorption to the common thickness turned out to be on the average about 12%; in the 'black' haze it was 24%. This was confirmed by results of observations in 1982 and 1983 [5].

The results of measurements on the natural illumination E_λ of a horizontal platform are shown in figure 1. According to figure 1, for the 'bluish-grey' haze, E_λ in the city in the visible spectral region is a little lower than E_λ obtained at the Observatory (in the infrared region, they almost coincide). For the 'black' haze the curve of the spectral dependence $E(\lambda)$ for the city in the visible region considerably differs from the corresponding curve for the Observatory. The spectral dependence $E(\lambda)$ for the city has a maximum wavelength of 0.6 μm. In the infrared

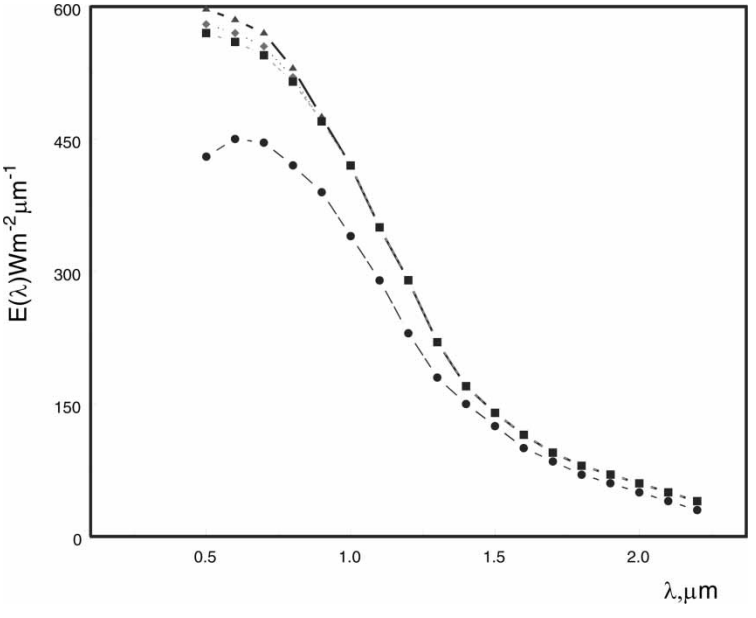

Figure 1. Spectral dependence $E(\lambda)$. The full triangles correspond to observations at the Observatory on 27 October 1981, the full diamonds represent the observations for the city obtained on 27 October 1981, the full squares show the observations at the Observatory on 3 November 1981 and the full circles correspond to observations for the city obtained on 3 November 1981.

region there is no visible difference between the spectral dependences even under conditions where a dense 'black' haze exists above the city.

The estimation of the microphysical parameters for the largest aerosol particles in the city haze and at the Observatory was carried out on the basis of measurements in the solar aureole. Both for the background and for urban aerosol particles the median size (in the log-normal distribution) has an obvious seasonal dependence. In summer the median size is larger. The difference between the sizes of urban and background aerosol particles is small. It was shown that the urban haze was formed, in general, from small particles. They did not scatter much radiation in the solar aureole region. For a more detailed description of the complicated and variable character of the urban haze it is necessary to make many measurements, to process them statistically and to carry out theoretical calculations of scattering for a two-layer atmosphere. Nevertheless, measurements of the optical characteristics of the urban haze allow us to obtain information about some properties of urban aerosols in their natural state.

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