ON THE FORMATION OF AVERAGE REGIONAL AEROSOL BACKGROUND

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The paper presents results of simultaneous measurements of the angular scattering coefficients at two spaced observation points. Based on an analysis of synoptic and meteorological conditions during the measurement period as well as on the comparison of experimental data obtained, the conclusions can be drawn about the commonness of processes determining the variability of the aerosol content in the atmospheric surface layer on a regional scale.

Because aerosol submicron particles have an extended lifetime in the atmosphere and are transported for long distances, it is evident that the effect of atmospheric processes of the entire range of spatiotemporal scales must be manifested through the variability of these particles.

In particular, in Ref. 1, based on simultaneous optical measurements in Moscow and Zvenigorod, scientists of the Institute of Atmospheric Physics have demonstrated that a variability of the aerosol content in the surface layer is primarily caused by processes of synoptic scale and regional level. At the same time, due to proximity of Zvenigorod to Moscow (a large industrial center with a great many anthropogenic aerosol sources), which determines in many respects the average regional aerosol background, a number of problems concerning the estimation of the contribution from natural and anthropogenic factors to the total variability of aerosol content remain unsolved.

In order to evaluate a possible spatial variability of submicron aerosol, we have performed the experiment on simultaneous measurement of the angular scattering coefficients μ (45°) at two spaced observation points. One of the observation points was near Tomsk (in Akademgorodok, on the south–east periphery of the town), and the second point was in Kireevsk, a suburban estate in a thinly populated forest zone on the river Ob' bank at a distance of 60 km to the south–west of Tomsk. Equipment and methods of measurement and absolute calibration were described in detail in Ref. 2. Measurements were carried out round the clock from July 11 till July 30, 1993 every hour in Akademgorodok and every two hours in Kireevsk.

Since the magnitude of aerosol light scattering is modulated by variations in the relative humidity, the correct comparison in investigating the variability of the aerosol content by the nephelometric method is possible when analyzing the coefficients of scattering μ (45°) by particles at zero relative air humidity. In Kireevsk our measurement cycle included a well developed and constantly used procedure of recording of μ (45°) variation attendant to the artificial increase of the relative air humidity[2] (recording of a hygrogram). The coefficients of scattering by dry material of aerosol particles μ_0 (45°) were determined from the experimental humidity dependence using the well–known Hanel formula.[3] In Akademgorodok, the setup automatically operated as part of the TOR–station,[4] and aerosol was dried out on heating the air in the main supplied to the nephelometer.

When analyzing meteorological data obtained at the TOR–station, we note that in the measurement period the eastern and south–eastern winds prevailed that is not typical of this region.

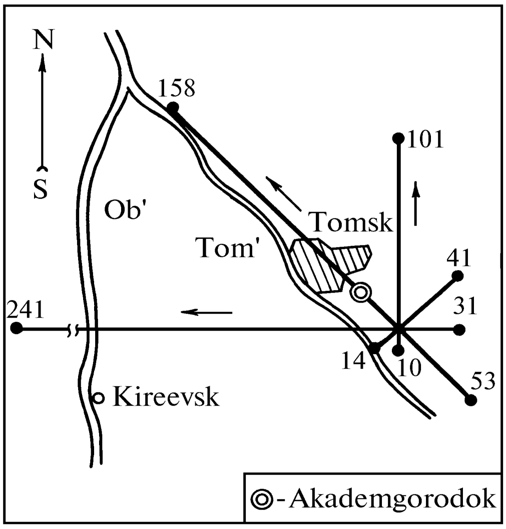

FIG. 1. Scheme of geographic arrangement of observation points and diagram of recurrence of the directions of aerosol transfer in Tomsk.

Figure 1 shows the diagram of the number of recorded air flow directions in July of 1993 from the data of observations made in Akademgorodok as well as the scheme of geographic arrangement of measurement points. From the figure, it may be concluded that the transport of anthropogenic aerosol in the south–western direction from Tomsk to Kireevsk is highly improbable. In addition, since in the observation period the wind was mainly directed toward the town and intense adjacent aerosol sources were absent to the south–east of Akademgorodok, it was safe to assume that measurements did not contain large anthropogenic addition. Thus, the probability of simultaneous entry of aerosol from Tomsk

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into the observation points for the period under study was very small. At the same time, in each specific measurement the random effect of local aerosol sources was possible that is superimposed on the total regional background. The effect of local aerosol sources can be lessen by increasing the period of data averaging.

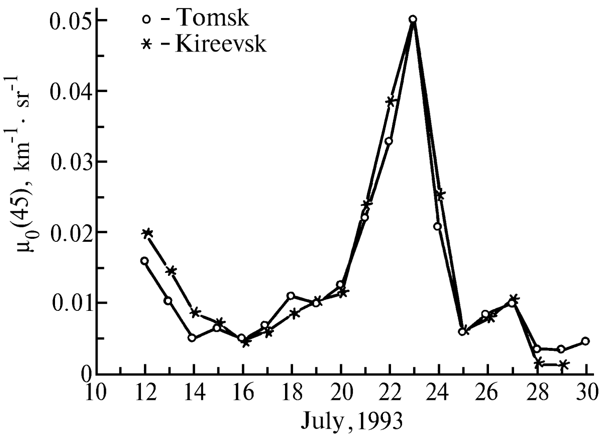

FIG. 2. Time dependence of the average daily coefficients $\mu_0(45°)$.

The time variability of average daily values of the "dry" angular scattering coefficient $\mu_0(45°)$ for both observation points is shown in Fig. 2. A certain decrease in $\mu_0(45°)$ on 12, 14, and 27 of July was due to weather front passage accompanied by rainfall. The atmospheric situation with aerosol accumulation, observed on 19–25 of July, was very typical of summer conditions, but in this case the process duration turned out to be rare. In this case, within the old arctic air mass with low–gradient baric field and weak cloudiness on 20–21 of July, the intense aerosol accumulation began that manifested through increase of the coefficient $\mu_0(45°)$ by almost an order of magnitude. A sharp decrease in $\mu_0(45°)$ resulted from the change of the old air mass to a pure arctic one on July 24–25. As one can see from Fig. 2, throughout the entire observation period the significant differences between the time dependence of $\mu_0(45°)$ for data being compared as well as between their absolute values were practically absent. The correlation coefficient between these values was equal to 0.92.

Such a high correlation points to the commonness of processes determining the variability of aerosol content at both points and confirms the conclusion about the regional scale of formation and transformation of most submicron aerosol in the ground atmospheric layer.

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