A SHORT–TERM ANOMALOUS DUSTINESS OF THE MIDDLE ATMOSPHERE OVER ASHKHABAD CITY

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During the night on 27–28 of September in 1988 an aerosol anomaly in the stratosphere was detected and studied. The anomaly was observed during three hours. This anomaly was assumed to be cosmic origin since no publications on any atmospheric emission of anthropogenic origin appeared in press.

A rapid increase of the power of the antropogenic aerosol emissions into the atmosphere has arisen such ecological problems as destruction of the ozone sheild of the Earth and global warming of the climate resulting in a greenhouse effect. In this connection observations of both natural and anthropogenic aerosols has recently attracted attention of scientists. Moreover, such observations should be done not only in the ground layer of the atmosphere, but in the stratosphere and mesosphere as well.

In this paper we discuss some results of lidar measurements of the anomalously high dustiness of the stratosphere occurred during the night on 27/28 of September, 1988. The main goal of the experiment, at that time, was to observe the aerosol scattering in the stratosphere at altitudes above the Yunge layer. In our experiments we used a lidar facility constructed at our institute. The lidar transmitter delivered 3 J energy per pulse of 1.5 μs duration at the wavelength of 589 nm within 0.3 nm wide line, the beam divergence being 1 mrad. The receiving system of the lidar involved a parabolic mirror 1.1 m in diameter with a focal length of 5 m and an interference filter with a transmission half–width of 0.5 nm, and a transmittance of 55%. A PMT FEU–136 cooled to –20° C which operated in a photon–counting regime was used as a photodetector. Photons were recorded with a photon counter providing for a range resolution of 0.5 km and 1 km constructed at the Khar'kov Institute of Radioelectronics. In our experiment we used a 1–km range resolution.

Shown in Fig. 1 are vertical profiles of the aerosol scattering coefficient β_a obtained from lidar data. The axis scales in the figure are the same for all profiles. The processing was accomplished using the procedure described in Ref. 1 (the method of calibration is based on the molecular scattering signal) and taking into account the correction for miscounts according to Ref. 2, assuming that our detector has a dead time of an extending type. Mean duration of the photoelectron pulse was about 6.5 ns. In the processing the profiles were calibrated by a signal from 25–km altitude and at that level the aerosol scattering coefficient could markedly exceed its background value. Figure 1 presents the data of intercomparison of the second profile and the model aerosol scattering coefficient under condition of anomalous dustiness of the atmosphere and between the last–obtained profile and the model scattering coefficient of the background aerosol (dashed lines) taken from Ref. 3. As can be seen from these comparisons, at the maximum of optical density of the aerosol cluster the measured aerosol scattering coefficient at altitudes higher than 35 km was much larger than the model coefficient of anomalous dustiness. From the last profile we may conclude that at the altitudes below 40 km there occured an aerosol washing out and at the altitudes higher than 40 km the aerosol scattering coefficient was larger than the model background value.

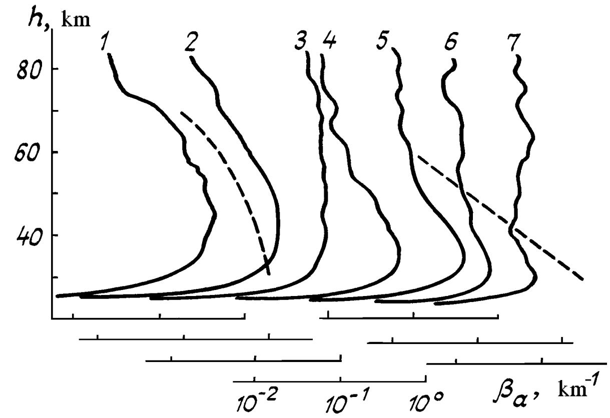

FIG. 1. Vertical profiles of the aerosol scatterring coefficient.

Based on the vertical profiles of the aerosol scattering coefficient shown in Fig. 1 the height–temporal isophot was constructed (see Fig. 2) which provides a good illustration for a spatio–temporal configuration of the aerosol cluster under study. We can infer from the vertical aerosol distribution that the aerosol cluster is of cosmic origin. After the passage of the cluster at the 65–68 km altitude we observed a layer with the aerosol scattering coefficient which was an order of magnitude larger than the background value. The dashed line in Fig. 2 which is constructed based on temporal change of the optical density maximum shows that aerosol particles rapidly descended.

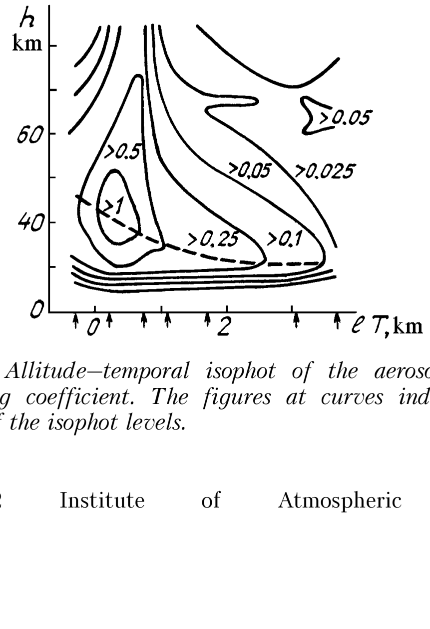

FIG. 2. Allitude–temporal isophot of the aerosol cluster scattering coefficient. The figures at curves indicate the values of the isophot levels.

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To evaluate a geometric size of the observed portion of the aerosol cluster we used the data of the radiosonde measurements of wind obtained two hours prior to the start of the lidar sounding. The diagrams of zonal and meridian winds are given in Fig. 3. The radiosonde ascended up to the 35–km altitude.

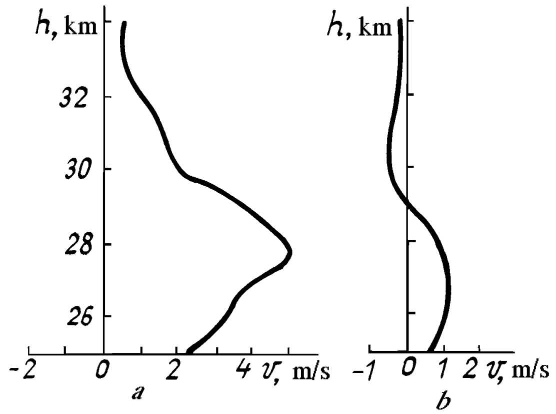

FIG. 3. Vertical profiles of the values of zonal (a) and meridian (b) winds, respectively.

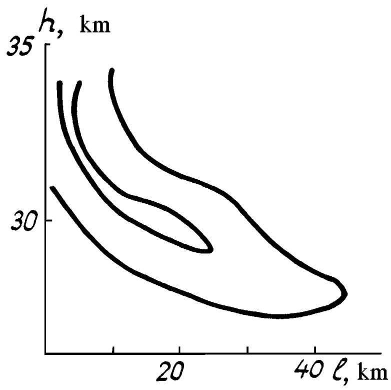

FIG. 4 Geometrical configuration of an aerosol cloud.

At the altitudes 30 to 34 km the wind blew from the west to east (12° to the north). The difference between the wind directions at the altitudes 30 and 27 km was 30°. A geometric shape of the observed aerosol cluster constructed for the values of the aerosol scattering coefficient $5\cdot10^{-5}$ and $2\cdot10^{-5}$ m^{-1} is shown in Fig. 4. The aerosol particles sedimentation and the wind direction were not taken into account in this figure. The aerosol formation had a shape of a track of an object coming into the atmosphere from the space. The aerosol formation observed in this experiment has no analogs among the formations we have earlier observed in the mesosphere and stratosphere after creation of an artificial cloud there as well as after a satellite burning[4] or the volcanic erruptions.[5]

The following conclusions can be drawn from the analysis of our observational results:

– the dustiness at the maximum of optical density exceeds the extremal model values;

– after the passage of the aerosol cluster there occurs clearing of the atmosphere at the altitudes lower than 40 km which can obviously be related to condensation of sulfurous acid vapors and coagulation of the aerosol particles;

– the aerosol particles are of cosmic origin; and,

– the aerosol layer is formed due to a strong dustiness at the altitudes from 65 to 68 km.

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REFERENCES

1. V.E. Zuev, G.M. Krekov, and M.M. Krekova, in: *Remote Sounding of the Atmosphere* (Nauka, Novosibirsk, 1978) pp. 3–46.

2. V.G. Astafurov and G.N. Glazov, ibid., pp. 146–153.

3. K.Ya. Kondrat'ev, N.I. Moskalenko, and D.V. Pozdnyakov, *Atmospheric Aerosol* (Gidrometeoizdat, Leningrad, 1983) p. 223.

4. O.G. Ovezgel'dyev, M.F. Lagutin, M. Berkeliev, et al., Izv. Akad. Nauk Tadzh.SSR, Fiz.–Mat.Geol.–Khim. Nauk, No. **6**, 108–110 (1981).

5. O.G. Ovezgel'dyev and Kh. Mamedov, Atmos. Opt. **1**, No. 8, 127–129 (1988).