TRACES OF THE PINATUBO VOLCANO ERUPTION IN THE STRATOSPHERE OVER WESTERN SIBERIA (TOMSK, 56°N)

V.D. Burlakov, A.V. El'nikov, V.V. Zuev, V.N. Marichev, and V.L. Pravdin

Institute of Atmospheric Optics, Siberian Branch of the Russian Academy of Sciences, Tomsk
Received March 24, 1992

An aerosol situation in the stratosphere over Tomsk is analyzed based on the data of lidar observations carried out from June 6, 1991 to March 6, 1992. It is shown that the first traces of the Pinatubo eruption were recorded over Western Siberia at the end of June about two weeks later the volcano eruption that is consistent with the velocity and trajectory of movement of the air masses at these altitudes during this period of time. Maximum loading of the stratosphere with aerosol of volcanic origin was observed on January 21 and 22, 1992. The scattering ratios determined during these days at a wavelength of 532 nm reached 9.5 at an altitude of 23.5 km. Such values of R were recorded over Tomsk for the first time during the last six years of regular lidar observations.

Regular lidar observations of the stratospheric aerosol have been carried out in Tomsk since 1985 using a stationary lidar on the basis of a 1–m receiving mirror and an LTI–701 Nd:YAG laser emitting at a wavelength of 532 nm (Ref. 1). At the start of our observations in January, 1986 we succeeded in recording the passage of volcanic cloud caused by the Ruis volcano eruption[2] (Columbia, November 1985).

The lidar observations of the stratosphere from the second half of 1991 up to date are of particular importance due to the Pinatubo volcano eruption in Philippins in June, 1991. This paper presents the individual profiles of the scattering ratio R (the ratio of the sum of aerosol and molecular backscattering coefficients to the molecular backscattering coefficient) obtained at a laser radiation wavelength of 532 nm which specify the aerosol state of the stratosphere over Tomsk from June 6, 1991 to March 6, 1992. The time of integrating the lidar signals in the photocurrent pulse counting regime required for determining an individual profile of R with 375–m spatial resolution and errors smaller than 10% was smaller than 20 min over the entire altitude range. The lidar and procedure for reconstructing R from lidar signals were described elsewhere.[3]

The aerosol situation in the lower stratosphere over Western Siberia within the 12–16 km altitude range in spring and summer of 1991 was formed by the air masses which arrived from the region of Persian Gulf through Western and Central Europe (see, e.q, a trajectory chart given in Ref. 4). In its turn, a stationary anticyclone formed over the entire southern region of Asiatic continent gave rise to a rapid air mass transport from Philippine to Persian Gulf.

Shown in Fig. 1 are the vertical profiles of R derived from the data of lidar observations carried out from June 6 to July 24.

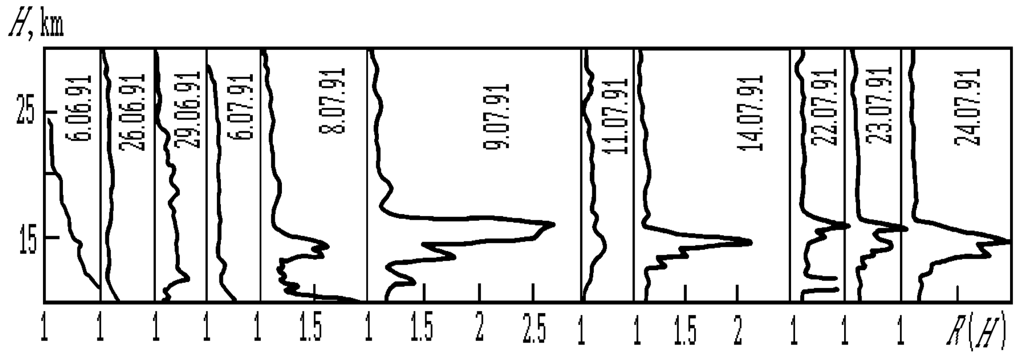

FIG. 1. Results of recording of the first traces of the Pinatubo volcano eruption over Tomsk during the summer run of the SATOR–91 measurements.

The aerosol pollution of the lower stratosphere on June 6 is much more likely related with echoes from the oil fires in Kuwait. The aerosol content in the stratosphere on June 26 was close to the background level. However, as early as on June 29 we observed a propounced aerosol layer at an altitude of 12 km. The aerosol situation at the altitudes of from 12 to 16 km sharply changed from July 6 to July 9. On July 9 the value of R in the maximum of the base aerosol layer at an altitude of ~ 16 km reached 2.7. On July 8 and 9 we observed a slightly pronounced aerosol layer with maximum at an altitude of 19 km; however, the stratosphere as a whole at

0235-6880/92/06 379-03 $02.00 © 1992 Institute of Atmospheric Optics

the altitudes above ~ 20 km remained unperturbed. The aerosol situation established in July varied but slightly to the end of September.

The joint analysis of lidar observations during summer period of the SATOR–91 and data on the trajectory of movement of air masses allowed us to assume that the recorded aerosol layers, starting from June 29, were the first traces of the Pinatubo volcano cloud.

Starting from the middle of October (see Fig. 2) we observed the aerosol loading at the stratospheric altitudes of from 10 to 30 km. From time to time the aerosol layers were recorded at the altitudes of from 30 to 35 km (e.g., on October 31 and December 2). The maximum values of *R* were recorded on January 21 and 22, 1992. In the layer centered at an altitude of 23.5 km they attained ~ 9.5 (Fig. 2). Below 20 km we also observed sufficiently thick aerosol layers in which *R* attained ~ 5.

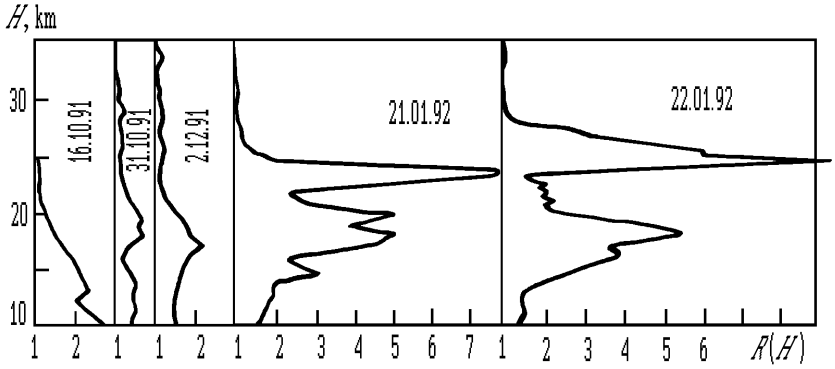

FIG. 2. Loading of the stratosphere over Tomsk by the volcanic aerosol from October 16, 1991 to January 22, 1992.

The regular lidar observations of the aerosol situation from January 31 to March 6 indicated transformations of the vertical profiles of *R* characterized by periodic decrease and increase in the aerosol layer thickness (see Fig. 3). The typical maximum values of *R* varied between 4 and 6. The transformations recorded were naturally related with the revolution of volcanic clouds in the Earth's stratosphere.

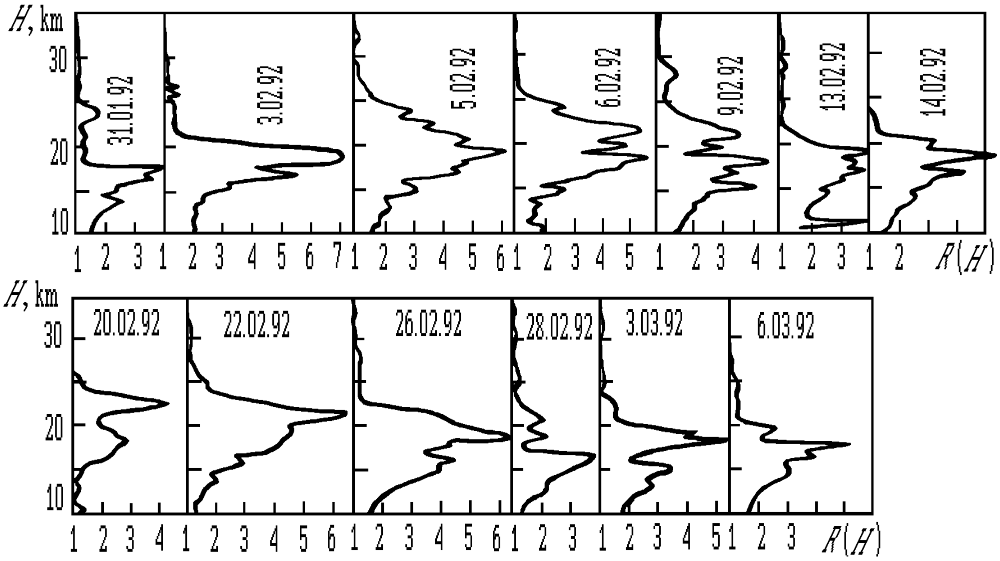

FIG. 3. Transformations of the vertical profiles of R in the stratosphere over Tomsk from January 31 to March 6, 1992.

It should be noted from comparison of the results of our lidar observations of volcanic stratospheric clouds caused by the eruptions of the Ruis and Pinatubo volcanoes that the maximum values of *R* recorded in our measurements in January, 1986 did not exceed 1.4. Such large values of *R* (up to 9.5) observed in the stratosphere perturbed by the Pinatubo volcano eruption were recorded for the first time over Western Siberia. It should be noted that the aerosol perturbation in the stratosphere can additionally be provoked by the fall eruptions of the Ethna volcano in Sicily.

We would like to thank M.V. Grishaev, A.V. Nevzorov, and E.V. Sharabarin for their help in performing the attendant lidar measurements.

REFERENCES

1. A.V. El'nikov, V.V. Zuev, and V.N. Marichev, Atm. Opt. **4**, No. 6, 462–465 (1991).

2. A.V. El'nikov, G.M. Krekov, and V.N. Marichev, Izv. Akad. Nauk SSSR, Fiz. Atmos. Okeana **24**, No. 8, 818–823 (1988).

3. A.V. El'nikov, V.N. Marichev, K.D. Shelevoi, and D.I. Shelefontyuk, Opt. Atm. **1**, No. 4, 117–123 (1988).

4. B.D. Belan, A.V. El'nikov, V.V. Zuev, V.E. Zuev, E.V. Makienko and V.N. Marichev, Atmos. Opt. **5**, No. 6, (1992).