# INTERCOMPARISON BETWEEN THE RESULTS OF SIMULTANEOUS GROUND BASED AND SPACEBORNE LIDAR SENSING UNDER THE LITE PROGRAM

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*Received October 4, 1995*

*Some results obtained from sounding tropospheric and stratospheric aerosol during ground based correlative measurements at the Siberian Lidar Station (Tomsk) within the framework of the NASA LITE Program in September, 1994, are presented. The results are compared with the data of spaceborne sounding.*

NASA has carried out the LITE (Lidar In-Space Technology Experiment) experiment[1,2] on laser sounding of the atmospheric parameters from onboard a Shuttle from space in September, 1994. The cloudiness parameters, atmospheric boundary layer characteristics, tropospheric and stratospheric aerosol, density and temperature of the stratosphere, as well as some characteristics of the earth's surface were planned to be measured during 9-day experiment from space. Spaceborne lidar based on a three-wavelength Nd:YAG laser (1064, 532, and 355 nm) and a 1-m diameter receiving mirror was designed for this purpose.

Correlative sensing of the atmospheric parameters from the ground was carried out during the experiment simultaneously with sounding of the parameters from space at the moments when Shuttle flew over the measurement site. The network of ground based stations of America, Europe, Asia, and Australia was involved into these measurement campaign. The Siberian Lidar Station (SLS) of the Institute of Atmospheric Optics in Tomsk (56.5°N, 85.1°E) has also been included in this network.

Sounding was carried out at SLS at the wavelengths of 1064, 532, and 355 nm. Lidar returns were received from the stratosphere with the mirror of 2.2 m diameter, and the tropospheric signals were received with the mirror of 0.3 m diameter. A more detailed description of the technique for lidar measurements at the SLS can be found in Refs. 3 and 4. Analysis of the results of stratospheric aerosol sounding at the wavelengths of 1064 and 532 nm which we have obtained during the ground based measurements under the LITE program is presented in Ref. 5. Now the data of spaceborne sounding at 532 nm wavelength obtained on September 10 and 17 are available for us and hence it is possible to carry out a comparative analysis of the results of ground based and spaceborne sounding.

Both cyclonic (before September 13) and anticyclonic meteorological conditions were observed in the city of Tomsk since 10 till 17 of September, that caused the weather change and the presence of clouds. Because of the cloudiness observed on September 10, only the data obtained on September 17 were used in the comparison. However, one should take into account that the spaceborne data were obtained from the orbit about ≈1000 km to the south from Tomsk.

The NMC data on temperature, interpolated to the Shuttle position, are shown in Fig. 1 in comparison with the data of radiosonde measurements carried out in Tomsk. As is seen from the comparison of the temperature profiles, the altitude of tropopause in the spaceborne sounding area is approximately 2 km higher than that over the lidar site in Tomsk (12 and 10 km, respectively).

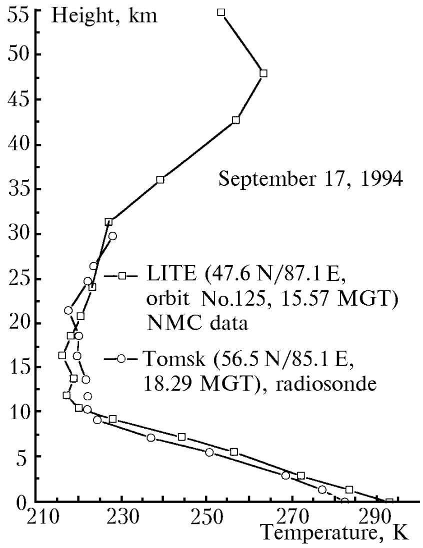


*FIG. 1. Profiles of temperature over the geographical sites of the ground based lidar and Shuttle during the sounding (MGT is the mean Greenwich time).*

Vertical profiles of the scattering ratio $R$ measured in the stratosphere at 532 nm wavelength from Shuttle (light line) and simultaneously from the ground (bold line) are shown in Fig. 2. For making the comparison, the results of lidar sounding were smoothed over 450 m spatial resolution for spaceborne lidar and 400 m for the ground based one. Maximum values of $R$ are comparable in both cases and reach 1.22–1.24. The profile structure and the values $R$ indicate the presence of aerosol traces of the volcanic origin in the lower stratosphere (the background value $R$ over Tomsk is 1.15). The shape of the $R$ profiles in the region of maximum values (these regions are marked by circles in Fig. 2) is identical. This region is 2 km higher for the spaceborne sounding data as well as the tropopause altitude. Thus, taking into account the latitude difference of the sounding sites, stratospheric profiles of $R$ are in a good qualitative agreement.

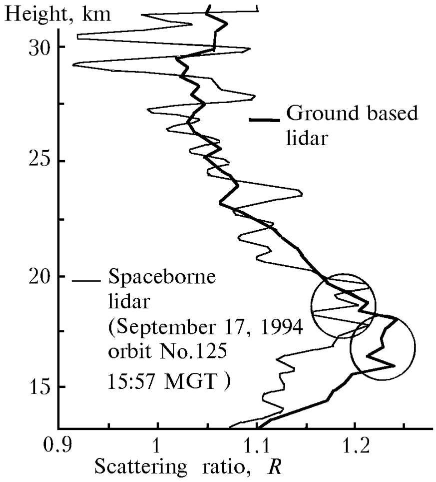


*FIG. 2. Vertical profiles of the scattering ratio in the stratosphere obtained from the data of simultaneous sounding from space and from the ground.*

In contrast to the stratosphere, the data of laser sounding in the troposphere are essentially different, what is quite obvious because of a significant distance between the measurement sites and high intensity of the dynamic processes in the troposphere at that time.

Vertical profiles of the aerosol backscatter $\beta_\pi^a$ determined from the data of spaceborne sounding (light solid line), ground based sounding with a stratospheric lidar (receiving mirror diameter is 2.2 m; bold line) and a tropospheric lidar (receiving mirror diameter is 0.3 m; dashed line) are shown in Fig. 3. The vertical profiles of $R$ and $\beta_\pi^a$ obtained with the lidar having the receiving mirror of 2.2 m diameter was limited from below by the mechanical chopper of the lidar return from the low distance zone of sounding. Comparatively low power of the ground based tropospheric lidar occurred to be not enough for obtaining representative data on the aerosol component in the stratosphere. These two factors make the problem of joining the aerosol profiles, obtained by the lidars with receiving mirrors of 2.2 and 0.3 m diameter, difficult. Nevertheless, it is seen from Fig. 3 that the aerosol situations in the troposphere over two sites are essentially different, as it follows from the results of ground based and spaceborne sounding, due to the aforementioned reasons.

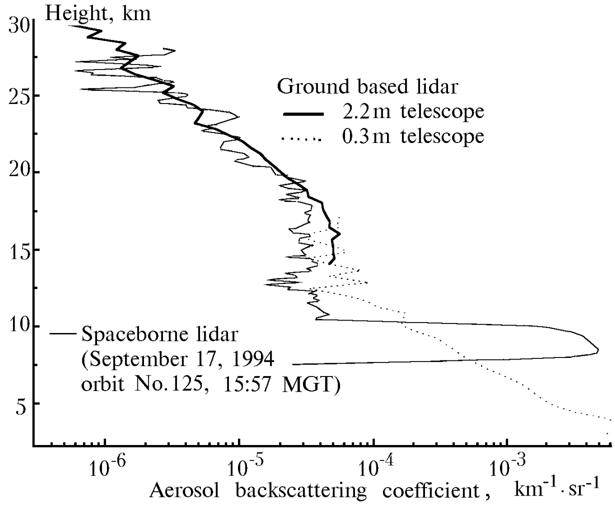


*FIG. 3. Vertical profiles of aerosol backscattering coefficient in the troposphere and the stratosphere, obtained from the data of simultaneous sounding from space and from the ground.*

Let us note for the conclusion that, taking into account the latitude difference of the sounding sites, the results of measurements of stratospheric aerosol from space and from the ground are in a good agreement.

## ACKNOWLEDGMENTS

The authors would like to thank the researchers of the laboratory of remote spectroscopy of the atmosphere for active participation in preparation and carrying out the lidar experiments and the researchers of the laboratory of optical weather for carrying out the radiosonde measurements.

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