25B4 STRATIFICATIONS AND SIZE DISTRIBUTIONS OF AEROSOLS DERIVED FROM SIMULTANEOUS MEASUREMENTS WITH LIDAR AND RADIOMETERS

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1. Introduction

Simultaneous measurements of aerosols with lidar, sunphotometer, and aureolemeter (scanning spectral radiometer) have been carried out at National Institute for Environmental Studies (NIES), Tsukuba, Japan since November 1991. In June of this year Mt. Pinatubo at Philippine erupted and injected huge amount of gases and aerosols into the stratosphere. Gases were converted to particles which have been suspended for a few years. Tropospheric aerosols are also suspended in the atmosphere as well as the stratospheric aerosols. The stratification of these aerosols is evaluated from lidar measurements although the size distribution is not obtained. On the other hand, size distribution of columnar aerosols is retrieved from spectral measurements of direct and/or scattered solar radiation. In this paper, therefore, we present a relationship between vertical structure and size distribution of aerosols by combining these measurements.

2. Instruments and Measurements

The lidar of NIES is composed of a YAG laser at wavelengths of 532 nm and 1064 nm and a large receiving telescope of 1.5 m in effective diameter. Both azimuthal and zenithal directions can be scanned with this lidar. Details are described by Shimizu et al. (1985). The lidar measurements of backscattering due to tropospheric aerosols and molecules were obtained at 1000 and 1400 LST with simultaneous radiometer measurements. Stratosphere was observed during night to avoid contamination by scattering of solar radiation. Vertical profiles of aerosol extinction coefficient were derived with the retrieval method by Sasano and Nakane (1987).

The aureolemeter is a spectral scanning radiometer for measuring solar aureole intensity. The wavelengths are 368, 500, 67, 777 and 862 nm. The scattering angles used in the analysis were 4, 5, 6, 7, 8, 9, 10, 12, 14, 16, 18, 20, 25 and 30°. Measured data were compared with theoretical calculation, varying the volume size distribution of aerosols which was obtained by an inversion technique. Thus aerosol volume size distributions in the air column were retrieved so as to agree the calculation with the measurement. Details of the aureolemeter and data analysis are described by Nakajima et al., (1986).

In order to obtain the aerosol optical thickness for extinction, a sunphotometer was used for measuring direct solar radiation at wavelength of 500 nm. The calibration of the sunphotometer was performed by applying the Langley method to the data.

3. Results and Discussion

One example of vertical profile of aerosol extinction coefficient is shown in Fig. 1 for the clear atmospheric condition. The volume size distribution of columnar aerosols simultaneously observed is also shown in Fig. 2. The size distribution with mode radius around 0.5 μm is clearly found, which seems to be stratospheric aerosols due to the Mt. Pinatubo eruption. In this case the optical thickness of tropospheric aerosols was estimated to be 0.077 from the lidar measurement where the extinction to backscattering coefficient ratio S1 was assumed to be 50. On the other hand, the columnar aerosol optical thickness was 0.251 from the sunphotometer measurement. Size distributions for the clear atmospheric conditions which seemed to be stratospheric aerosols were expressed with a log-normal function. The temporal variation of the mode radius thus obtained is shown in Fig. 3. The mode radius was found to increase from 0.5 μm to 0.6 μm during about one year from November 1991.

Another examples of vertical profile and size distribution of aerosols are shown in Figs. 4 and 5, respectively. In this case, aerosols were heavily loaded in the middle troposphere. The retrieved aerosol size distribution showed abundance of large particles. Such properties were often observed in the spring season. In this season, over Japan and the Western North Pacific, soil derived particles from the Asian Continent are known as the Yellow Sand Event (Tanaka et al., 1989). The phenomena observed in this study suggested that the aerosols of the Yellow Sand Event came flying in the middle troposphere.

In this study, the advantage of simultaneous measurements with lidar and radiometer was shown. From these measurements, relationships between stratifications and size distributions of aerosols were obtained.

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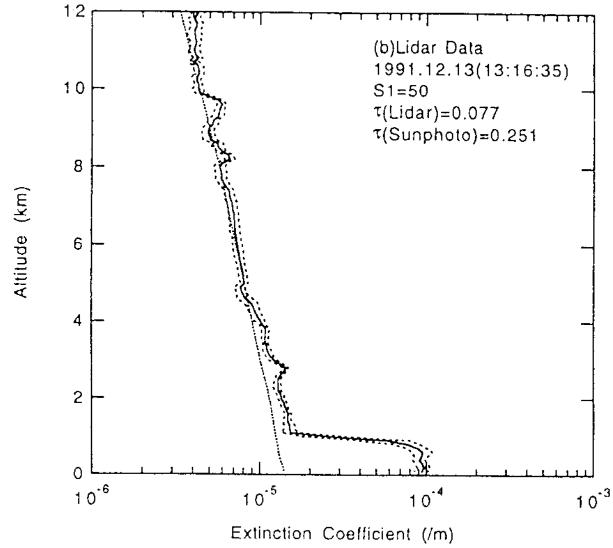

Fig. 1. Vertical profile of aerosol extinction coefficientin a turbid atmospheric condition.

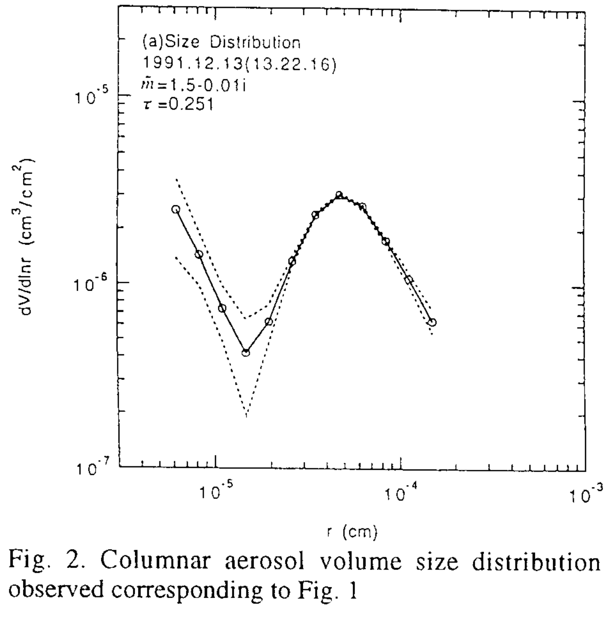

Fig. 2. Columnar aerosol volume size distribution observed corresponding to Fig. 1

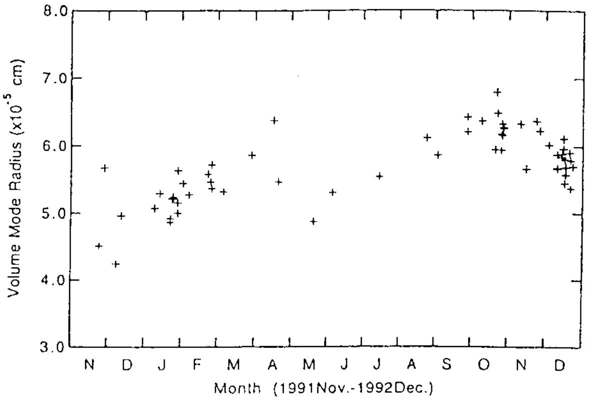

Fig. 3. Temporal variation of the mode radius of stratospheric aerosols

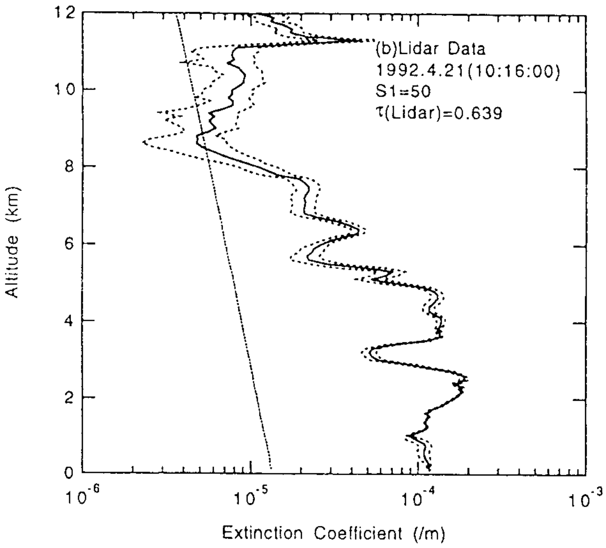

Fig. 4. Vertical profile of aerosol extinction coefficient in a turbid atmospheric condition.

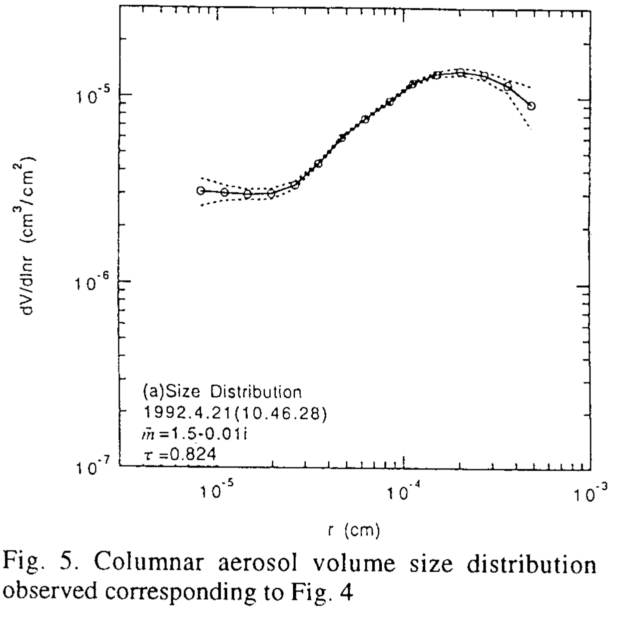

Fig. 5. Columnar aerosol volume size distribution observed corresponding to Fig. 4