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Volcanic Eruptions and the Increases in the Stratospheric Aerosol Content - Lidar Measurements from 1982 to 1986

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This paper describes the results of the observation for stratospheric aerosols which we have been carrying out since the autumn of 1982 by using the NIES large lidar.

Specifications of the lidar system are shown in Table 1. The lidar has two wavelengths of 1.06 um and 0.53 um. We use mainly 0.53 um for the stratospheric aerosols, because the PMT for 0.53 um has higher sensitivity than that for 1.06 um and the total efficiency is higher in the former. A switching circuit is used to control the PMT gain for avoiding signal-induced noise in PMT (Shimizu et al., 1985).

For the last four years, we have observed the stratospheric aerosol layer significantly perturbed by the El Chichon volcanic eruption (March and April 1982, Mexico). The scattering ratio profiles observed from 1982 through 1983 are shown in Fig.1. The integrated backscattering coefficient in the height region from 12km to 27km (IBC) was about $6\text{-}7 \times 10^{-3}$ /sr^{-1} in the winter of 1982/83 when IBC became largest in mid-latitudes(e.g. Hayashida and Iwasaka, 1985). Through 1983, the aerosol layer became broader and the IBC decreased to about $2\text{-}3 \times 10^{-3}$ /sr^{-1} in the winter of 1983/84.

Through 1984 and 1985 the stratospheric aerosol layer was almost quiet and the peak value of the scattering ratio was about as large as 1.2-4 for the whole stratosphere.

On December 11 and 12, we found a new aerosol layer around 18km in altitude. The peak value of the scattering ratio was only about 1.4 and fluctuated. However, we believe this new aerosol layer should be attributed to a volcanic eruption, because there had been no evident peak around 18km through November 1985. Fig. 2 shows the profiles of the scattering ratio observed from November, 1985 through February, 1986. Since the signals were collected with a sampling time of 500nsec (=75m of spacial resolution), we could find the peak layer very clearly in spite of the fact it was very thin. The new layer seems to have appeared already on December 1, though the peak value of scattering ratio was only about 1.3. The new aerosol layer on December 11 and 12 was confined to only about 1km in thickness. On December 13 and 16, the layer became more obscure while another thin layer appeared around 22 km. Through December, 1985, the aerosol layer around 18km was observed continuously, but the peak value of the scattering ratio was only as small as 1.3. The upper aerosol layer around 22km in altitude began to increase in scattering ratio on January 6. On January 9 and 10, the scattering ratio

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of the upper layer increased to about 2.8. However, the peak value of the scattering ratio obtained after January 14 shows a fluctuation. This fact indicates that the aerosols came over the lidar side at Tsukuba sporadically, suggesting a large-scale fluctuation in high-altitude air flow.

At Mauna Loa, Hawaii, a distinct new layer was observed on November 26 and 27 at 25-25.5 km (SEAN Bulletin, 1986). On December 5, a 10-fold increase in condensation nuclei was detected by balloon-borne counters between 15-17 km in altitude over Wyoming (41 N,105.5 W). These new aerosols are considered to have their origin in the eruption of the volcano Nevado del Ruits on November 13, 1985 in Colombia (SEAN Bulletin, 1986). The aerosol layers observed by the NIES lidar would be attributed to the Nevado del Ruitz eruption, although further verification is required.

References

1)Shimizu,H., Y. Sasano, H. Nakane, N. Sugimoto, I. Matsui, and N. Takeuchi (1985); Large scale laser radar for measuring aerosol distribution over wide area. Appl. Opt., 24, 617-626.

2) Hayashida, S. and Y. Iwasaka (1985); On the long term variation of stratospheric aerosol content after the eruption of volcano El Chichon: Lidar measurements at Nagoya, Japan. J. Meteor. Soc. Japan, 63, 465-473.

3) Scientific Event Alert Network (1986); Smithsonian Institution.

Table 1 Specifications of NIES LAMP lidar

Laser		
Material	Nd: YAG	KD*P (SHG)
Average output power	30 W	10 W
Output energy/pulse	1.2 J	0.4 J
Repetition rate	25 pps	
Pulse duration	15 nsec	
Beam divergence	0.3 mrad	
Receiving telescope		
Type	Cassegrain	
Effective aperture	1.67 m	
Focal length	8 m	
Spot size on focus	1 mm	
Scanner		
Scan type	azimuth-elevation	
Scan rate	600-0.25 deg/min	
Accuracy of aiming	1 min (0.3 mrad)	
Accuracy of scan	1 min (0.3 mrad)	
Light transmission	Semi-Coude	
Receiving optics		
Field of view	0.15-4.8 mrad	
Monochromation	If filters and double monochromator	
Band width of filters	0.7 A	1.5 A
Transmittance of filters	12%	24%
Focal length of monochromator	30 cm	
Signal processor		
Type	Digital processing	
Min. sample rate	10 nsec	
Accuracy	8 bits	
Memory	2 ch: 2048 words/ch	
Data processor		
Type	Mini computer-large computer combined system	
Mini computer	TOSBAC 7/40D	
Large computer	HITAC M-180	

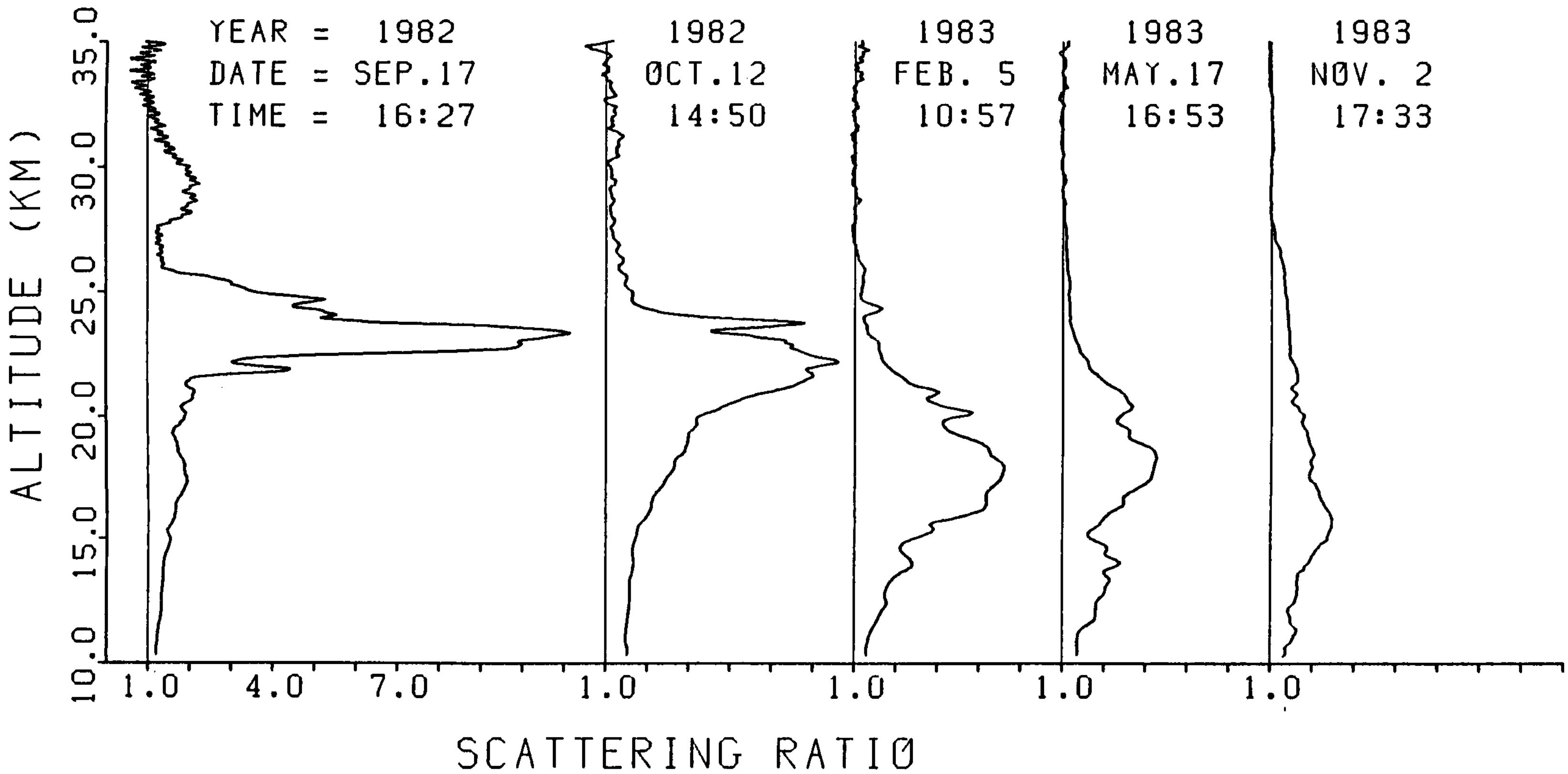

Fig. 1. The scattering ratio profiles from September 1982 to November 1983.

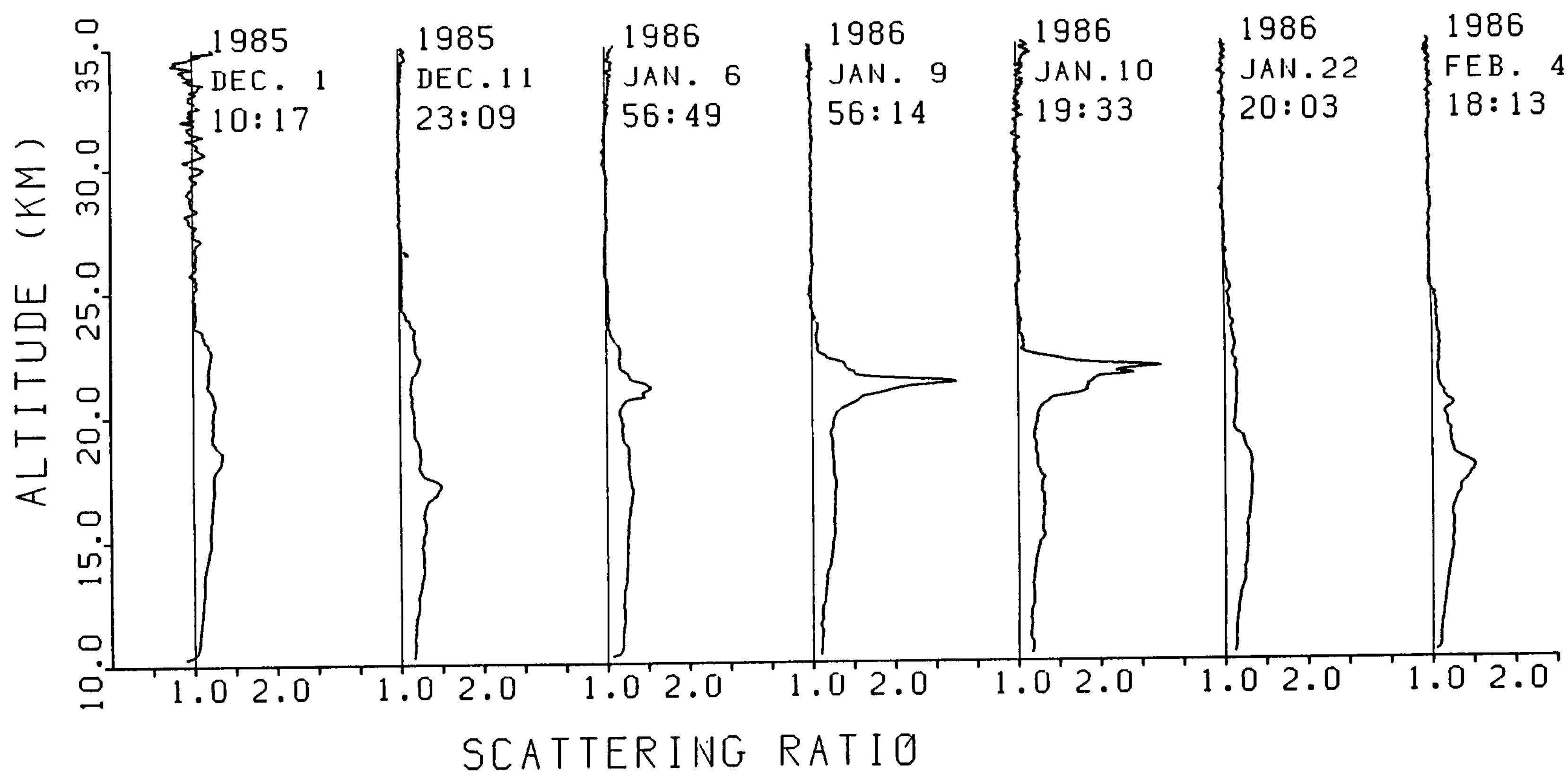

Fig. 2. The scattering ratio profiles from December 1985 to February 1986.