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LIDAR MEASUREMENT OF STRATOSPHERIC AEROSOL AT SYOWA STATION, ANTARCTICA

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Lidar measurements on Antarctic aerosol were made during the AMA (Antarctic Middle Atmosphere) period, 1983-1985 at Syowa Station (69°00'S, 39°35'E). Topics measured are winter enhancement aerosol layer and volcanic effect of El Chichon on the Antarctic stratospheric aerosols.

Introduction

An extremely enhanced stratospheric aerosol layer, which was named Polar Stratospheric Clouds by McCormick et al. (1982) on the basis of satellite measurements SAM II, was observed by lidar. The noticeable increase in aerosol content possibly affects various fields: global budget of stratospheric water vapor, glogal budget of stratospheric sulfur compounds, sediments of sulfur on ice sheet of Antarctic land, and active formation of cirrus clouds in the winter Antarctic troposphere.

The volcanic effect on El Chichon was suggested from a long-term trend in the variation of the aerosol content from the vertically integrated backscatter coefficient. Chemical analysis on the ice core sampled in the Antarctic and Arctic regions revealed the presence of " Anomalously Enriched Elements " due to a possible global dispersion of volcanic materials into the stratosphere by severe volcanic eruptions (Mitchell, 1975; Boutron, 1980). There is a possibility that the winter enhanced aerosol layer plays an important role in the transport of such volcanic materials from the stratosphere to the ice surface.

In this report lidar measurements made at Syowa Station

(69°00'S, 39°35'E) are presented.

Lidar measurements

Specifications of lidar used here are described in Table 1 (detailed description was given by Iwasaka et al. (1985a)).

Integration given by the following equation is a useful parameter to discuss the change of stratospheric aerosol content

$$I = \int_{Z_1}^{Z_2} B(Z)dZ$$

where Z_1 and Z_2 are top and bottom height of aerosol layer respectively. The value increased to be about $2 \times 10^{-2} sr^{-1}$ in the winter of 1983. A comparable value was measured also in the winter of 1985.

Depolarization ratio is defined here by

$$D(Z) = P_{\perp}(Z)/P_{/\!/}(Z)$$

where $P(Z)_{/\!/}$ and $P_{\perp}(Z)$ are parallel and perpendicular components of the polarization plane of received pulse to emitted pulse plane. A large depolarization ratio of the stratospheric aerosol layer was measured during the winter enhancement (Iwasaka et al., 1985a; Iwasaka et al., 1985b; Iwasaka, 1986).

Comparing the aerosol densities measured in fall and in spring of 1983, 1984, and 1985, there is systematic decrease due to the possible effect of the El Chichon eruption. Concerning the winter measurements in 1983 and 1985, there is not a noticeable difference between them.

Discussion and summary

The large depolarization ratio (maximum value was about 0.8) seems to support sublimation growth of ice crystals (Swissler et al., 1983). The lidar measurements showed a meaningful time lag between aerosol content increase and depolarization ratio increase. Considering the balloon observations made in early winter, we can speculate an increase in large particle number concentration also contributed to the winter enhancement.

The El Chichon cloud spread to the Antarctic region by the beginning of 1983. The temporal change of integrated backscatter coefficient shows a clear decay pattern, although strong winter enhancement superposes. The decay time scale is estimated by

$$I(T) = I(0)\exp(-T/\tau)$$

where T and τ are observational time and characteristic time of decay. The time scales estimated are summarized in Table 2. Time scales seem to be a little longer compared with estimations made on the mid/low latitude stratosphere. This may be due to active transportation of volcanic particles and related gases by stratospheric air motion.

References

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Table 1
Specifications of lidar

Transmitter	
Laser output	694nm <1J/pulse
	347nm < 0.4J/pulse
Repetition rate	60ppm (Max)
Transmitter beam divergence	0.5 mrad
Receiver	
Receiver optics	Cassegrain telescope
Receiver diameter	500 mm
Detection system	
3-channel detection (typical configuration)	
A-channel	photoncounting (347nm)
B-channel	photoncounting (694nm)
C-channel	Analog detection (694nm)
Data processing	
CAMAC data logging system with minicomputer	

Table 2
Characteristic decay time

observation period	time scale
1983/3 - 1983/10	1.37 year
1983/3 - 1985/3	1.42 year