# OPTICAL PROPERTIES OF LIDAR－OBSERVED PSC ON THE EARLY STAGE OF PSC FORMATION OVER DOME STATION, ANTARCTIC

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**ABSTRUCT**

Lidar observation at Dome Fuji (77.3S, 39.7E) from April 1997 to January 1998 was carried out. In the winter, many PSCs events in the stratosphere under low temperature condition were detected. The behavior of scattering ratio and depolarization ratio of PSCs detected from end of May to mid June 1997 showed similar tendency to those observed in Arctic. Some PSC layers composed mainly of solid particle were detected at the temperature close to frostpoint of ice. The backtrajectory analysis for the solid PSC show PSC layers experienced at the temperature lower than the frostpoint of ice before the observation time.

**1. INTRODUCTION**

Since the discovery of a drastic reduction in the stratospheric ozone over Antarctic, it has become increasingly clear that changes in the composition, phase, and size of stratospheric aerosols, and reactions in or on them, can strongly perturb the chemistry of stratosphere. Especially, polar stratospheric clouds (PSCs) are considered to play important roles in ozone depletion because reactions on PSC particles in the cold stratosphere are now known to convert the relative inert chlorine “reservoir” species HCl, HOCl, and $ClONO_2$ into photochemically reactive forms such as $Cl_2$, which can destroy ozone through gas phase catalytic cycles. Recently extensive research has produced a detail picture of PSC structure and composition. However, prior attempts to explain well enough the formation of solid particle, particularly type Ia of PSCs, and composition of PSCs by recent theories have been inconclusive.

We performed the lidar observation at Dome Fuji (77.3S, 39.7E) from April, 1997 to January, 1998. Many PSCs events in the stratosphere under low temperature condition were detected. On the early stage of appearance of PSC from end of May to mid June, we detected many PSC composed mainly of solid particles and liquid particles. We found a similar temporal series in the behavior of PSCs with the decrease of temperature to those observed in the arctic reported by [1] and [2]. In mid June 1997, the invasion of blocking high into the polar vortex was observed and not only the troposphere but also the stratosphere above Dome Fuji was disturbed seriously. The temperature of the stratosphere above Dome Fuji became lower than the ice frost point, when the extreme enhancement of high particle concentration (scattering ratio over 150) was detected, which was presumably the echoes from ice cloud. After that, only PSC layers composed mainly of solid PSCs were frequently detected.

In this paper, we focused the view of PSC formation on the early stage of development of PSC. We analyzed lidar data obtained from the end of May to mid June 1997. This paper describes the result of PSCs observation of that period, and discusses the temporal behavior and formation process of PSCs, especially solid PSCs using trajectory analysis and box model of PSCs.

**2. DESCRIPTION OF THE LIDAR SYSTEM**

Lidar observations at Dome Fuji were made using both the fundamental (1064nm) and the second harmonic (532nm) wavelengths of a Nd:YAG laser. The output energy of the lasers is 150mJ/pulse at each wavelength, with the pulse repetition rate of 20 Hz. Backscattered light is collected by a 28 cm Schmidt Cassegrainian telescope and split by some dichroic mirrors and a polarizing beam splitter into five channels of the light detecting system, each including a photomultiplier, an interference filter and some other optics. Two channels detect backscattered signals in planes parallel and perpendicular to the primary polarization plane of the transmitted laser light (532nm). The other two channels measured the signals of fundamental wavelength (1064nm) and the Raman scattering signals from $N_2$

molecules respectively.

### 3. RESULT

Fig. 1 shows the vertical profiles of scattering ratio (R), depolarization ratio (D) and Angstrome coefficient observed on May 28, 1997. The enhancement in both R and D can be seen between 15 and 20 km in the cold area where the temperature is lower than the frost point of NAT (TNAT), which is estimated using the vapor equilibrium equation [3] under the assumption that the air mass of interest has mixing ratios of 5ppmv H2O and 10 ppbv HNO3, respectively. It means that the aerosol layer of interest contains non spherical particles such as NAT and SAT. We detected first echoes on May 28 in the winter and we frequently detected PSCs with moderate R and relatively large D as shown in fig.1 at beginning of the appearance of PSCs in the winter. According to lowering temperature, PSCs composed mainly of liquid particle frequently detected. Fig. 2 shows the profile obtained on June 9. We can see the liquid layer with low depolarization (15-20km) was sandwiched by lower and upper solid layers (13-15.5km, 20-24km). At the temperature close to the frost point of ice, layers composed mainly of liquid particles were frequently detected. At the temperature 2-3K lower than TNAT, solid PSC were frequently detected. As the temperature decreases close to frost point of ice, liquid PSC were detected frequently and predominantly. Such series of appearance of PSC with decreasing temperature were reported by [1] and [2] in the Arctic. They explained this process from the point of view of difference in the nucleation ratio of two types of particles, particularly slow nucleation ratio of solid particles at low temperature. Fig. 3 shows temperature histories for solid and liquid layers, respectively. We also show the frost points of NAT, STS and ice. We estimated their frost points from water vapor and nitric acid vapor obtained by ILAS version 5.0. We cannot recognize clear difference in temperature history between solid layer and liquid layer. But we can see clear tendency that solid PSC were detected at 0-3K lower than TNAT. In the temperature range between frost point of STS and ice, liquid particle were frequently detected. But some solid layer were detect in the temperature range. The temperature histories for such solid layer show that most solid layer experienced at the temperature lower than frost point of ice before the observation. In our presentation, we also discuss the formation process of such PSCs, using box model of PSCs.

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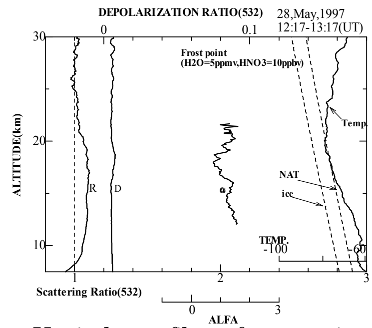


Fig.1 Vertical profile of scattering ratio(532nm), depolarization ratio(532nm), Angstrome coefficient, temperature and estimated NAT and ice frostpoint observed on 28 May, 1997 above Dome Fuji, Antarctic.

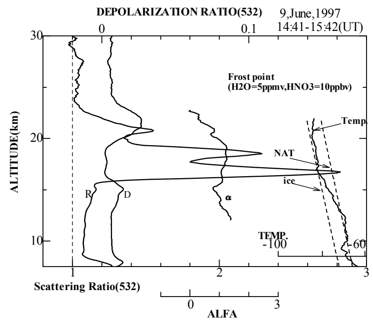


Fig.2 Same as Fig.1 except on June 9,1997

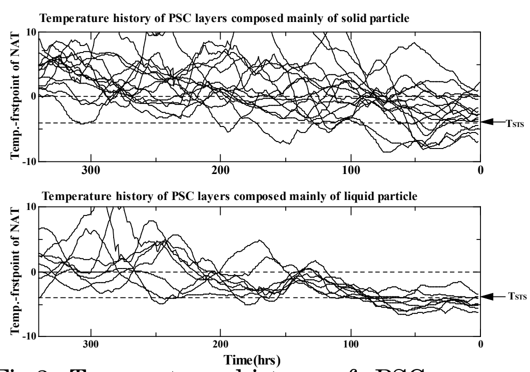


Fig.3 Temperature history of PSC composed mainly of solid and liquid particle.