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Study of Stratospheric Aerosol over Bandung-Indonesia

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INTRODUCTION

Ground based instruments have played an increasingly important role in studies of the Earth's atmosphere. Operating at shorter wavelengths, lidar has proved to be a powerful technique which can be complementary to radar measurement. Both techniques rely on the backscattered signal from some scattering media and the relevant scattering processes. However, being at optical wavelength, lidar is more useful in detecting the neutral species in the atmosphere including molecules and particles. Lidar has been extensively utilized for the studies of PSC's cloud and Pinatubo aerosols (Iwasaka et al. , 1991); both have tremendous impacts on the earth's atmosphere recently.

. In order to understand the role of the stratospheric aerosols , it is important to monitor the variations in the amount of stratospheric aerosols as well as their heights and latitudinal variations. Many lidar measurements have been made on the stratospheric aerosol layer to date. Lidar measurements have many advantages in moni toring the stratosphere, such as the possibility of profile measurements, heigh frequency of measurement etc

The equatorial region where raw materials of the stratospheric aerosols are supplied through active convection is a blank area for lidar observations. Then, lidar system were installed in Bandung (6.9°S ; 107.7° E) Indonesia under collaboration between National Institute of Aeronautic and Space (LAPAN), Communication Research Laboratory of Japan and Meteorological Research Institute of Japan. In the end of the year 1996, the lidar system was installed completely.

SYSTEM DESCRIPTION

The lidar transmitter system employ fundamental (1064 nm), second harmonic (532nm) and third harmonic (355nm) wavelengths of Nd: YAG laser are transmitted. The second harmonic backscatter light and its N_2 raman backscatter light (607nm) are collected by a 28 cm and a 35 cm diameter telescope. In 35 cm telescope system, upper troposphere and stratosphere are observed by photon counting. 532 nm light components polarized parallel and perpendicular to the laser light are separately observed to get information about shape of aerosol. The parallel component is divided to lower altitude channel and upper altitude channel to expand dynamic range of detection system. The upper and lower altitude channels data are connected around 20 km and combined to form a height profile of parallel component. The raman backscatter channel includes only the signal from molecular N_2 and is used as a reference for the atmospheric molecule distribution and extinction. Laser light of 1064 nm and 355 nm are used for backscattering measurement at each wavelengths and for raman backscattering measurement at 386 nm by H_2O and at 408 nm by N_2. The system parameters are listed in table 1 (Mizutani K. et al, 1997).

Table 1. Lidar system at LAPAN, Bandung – Indonesia

Transmitter			
Laser	Nd: YAG Laser	with SHG and	THG
Wavelength	1064 nm	532 nm	355 nm
Output Energy	400 mJ	200 mJ	580 mJ

Repetition rate	10 Hz	
Beam divergence	< 0.1 mrad	
Receiver (532 nm and 607 nm system)		
Telescope diameter	35 cm	28 cm
Field of view	1.0 mrad	1.4 mrad
Height resolution	60 m	15 m
Detector	PMT(R3234x4)	PMT(R3234x2)
	Px2, S, Raman(N2)	P,S
Method of detection photon counting		

SUMMARY OF RESULTS

Figure 1 shows the vertical profile of photon counting measured on September 17, 1997. The total number of laser shots was 3000 and the observation time was 111 minutes and the vertical resolution was 60 m. The dotted line is the expected lidar signal from the atmospheric molecules for the 1976 US standard atmosphere model. From this figure, the stratospheric aerosol layer and cirrus cloud layer were clearly detected. The cirrus cloud appeared between 14 and 15 km altitude and the thin stratospheric aerosol layer distributed over 18 km to 40 km.

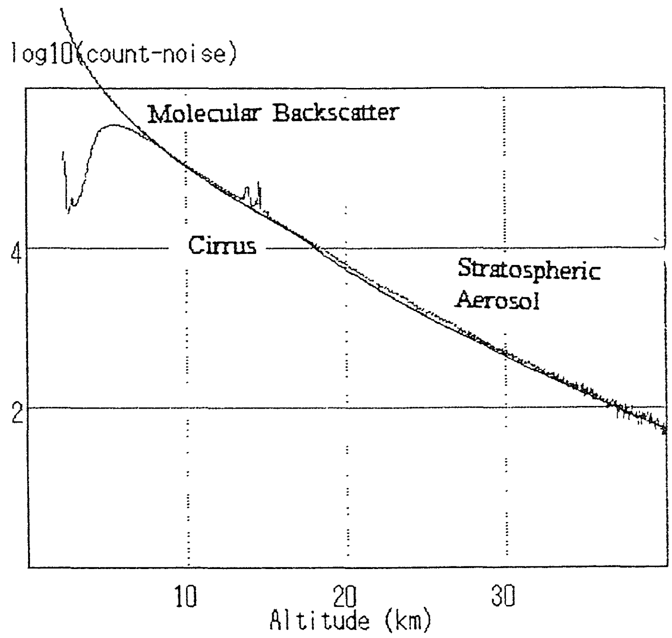

Figure 1. The vertical profile of photon counting on September 17, 1997

Figure 2 is the vertical profile of scattering ratio R(z) and depolarization ratio DR(z) on June 9, 1999. The scattering ratio R(z) is defined as :

$$R(z) = \{\beta_m(z) + \beta_a(z)\} / \beta_m(z)$$

where $\beta_m(z)$ and $\beta_a(z)$ are respectively the molecular and aerosol backscattering coefficients. and depolarization ratio is defined as :

$$DR(z) = \{\beta_m(z) + \beta_a(z)\}_{\perp} \ / \ \{\beta_m(z) + \beta_a(z)\}_{//}$$

where // and $\perp$ mean parallel and cross components of backscatter light to the polarization plane of emitted laser light. Polarization properties of backscatter light has no change when spherical particle scatter light. Therefore parameter of DR can be considered as the value indicating nonspherisity of particles (Iwasaka et.al. 1996).

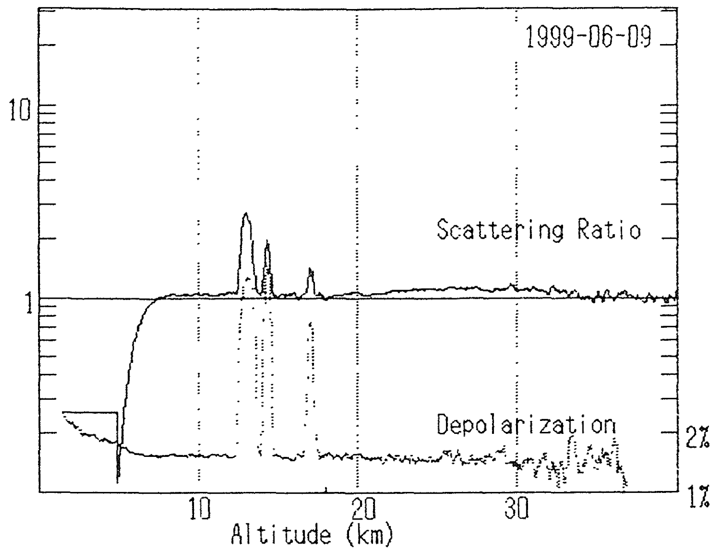

Figure 2. The vertical profile of scattering ratio and depolarization ratio

Figure 3 is an example of the backscattering coefficient profile on June 2, 1999 which shows profile of stratospheric aerosol concentration. The maximum of backscattering coefficient in Bandung is found approximately at 22.5 km altitude and sometime has 2 sub layer. First layer formed between 18 and 30 km and the second layer appear between 30 and 35 km. Decreasing of backscattering coefficient near 18 km maybe correlate with minimum temperature in the tropopause. Observations by radiosonde in Bandung indicate that the tropopause is found around 18 km altitude and the minimum temperature reach 190°K.

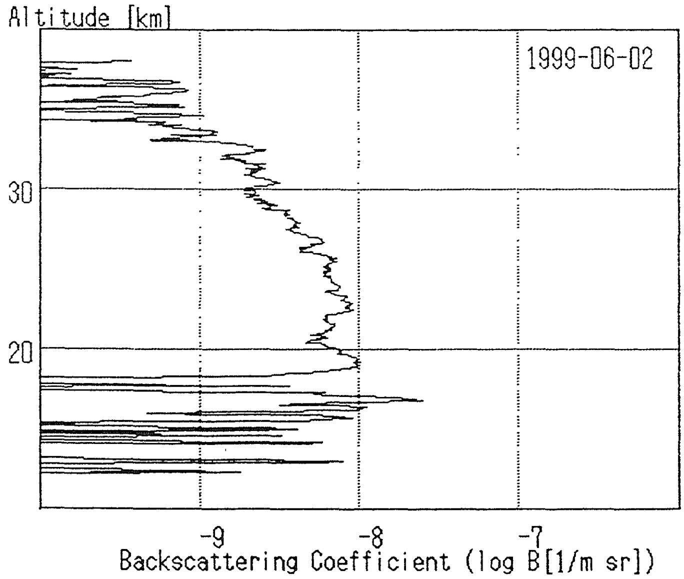

Figure 3. The backscattering coefficient on

Figure 4 is the time series of integrated backscattering coefficients in the period of observation : April 1997 until mid of June, 1999 for two altitude range. The circle represents the integrated backscattering coefficient between 10 km and tropopause (18 km) and the black doted is the integrated backscattering coefficient between 18 km and 35 km. It was obtained that the integrated backscattering coefficient of stratospheric aerosol between 18 and 35 km concentrated in the range of 1.0 E-5 and 1.0 E-3 sr^{-1} , while the integrated backscattering coefficient from 10 to 18 km was 1.0 E-4 to 1.0 E-1 sr^{-1}. The large different of integrated backscattering coefficient between two altitude range it is possibly caused by clouds which always cover Bandung during lidar observation. Geographically, Bandung is located at about 750 m above mean sea level and it is surrounded by mountains, therefore cloud easyly formed.

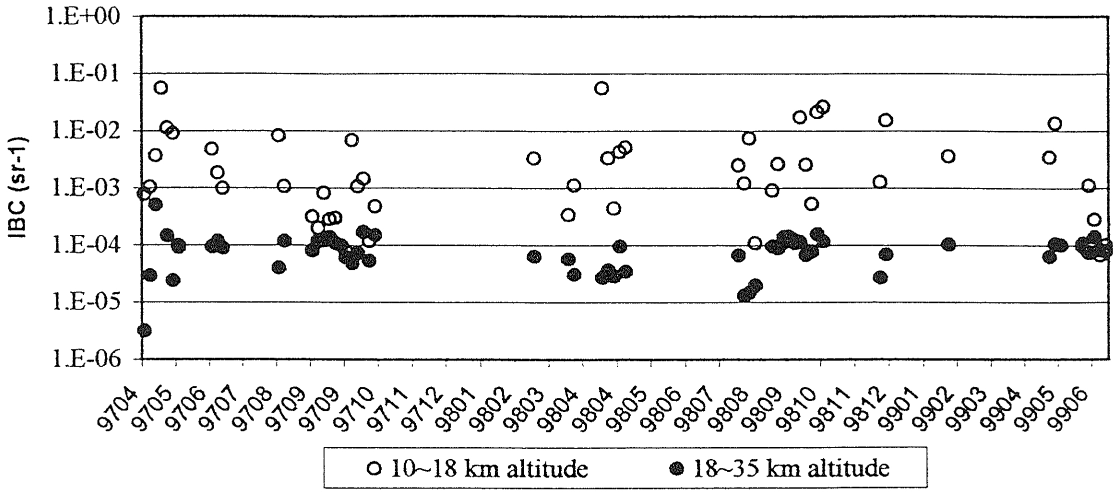

Figure 4. The time series of integrated backscattering coefficients

Based on time series of integrated backscattering coefficient above the maximum value of integrated backscattering coefficient of aerosol was 5.0 E-4 sr^{-1} in April 12, 1997 and the minimum was 3.2 E-6 sr^{-1} in April 9, 1997 Comparing with the integrated backscattering coefficient in Tsukuba which displayed a seasonal variation with a winter maximum (O.Uchino,1995), the seasonal variation of integrated backscattering coefficient in Bandung does not so clear yet. The depolarization ratio between 18 to 35 km it is obtained less than 4%.

REFERENCES :

1. Mizutani K et.al : "Lidar Observations of the Aerosols in the Equatorial Region". Proc. of the Tsukuba International Workshop on Stratospheric Change and Its Role in Climate and on the ATMOS-C1 Satellite Mission, pp.113-114, 1997.
2. Iwasaka Y, M. Hayashi. "Two Different Stages in Polar Stratospheric Clouds Events : Lidar Backscatter of Particulate Matter and Temperature in the Antarctic Stratosphere". J. of the Meteorological Society of Japan vol. 69, No.1 ,pp.71-80, 1991.
3. Iwasaka Y, T. Shibata, H. Adachi, T. Ojio, M.Fujiwara, K. Shiraishi, K. Miyagawa, H. Nakane. "Polar Vortex Meandering and Stratospheric Aerosol Distribution : Lidar Measurements at Fairbanks, Alaska". J. Geomag. Geoelectr., 48, pp.1157-1167,1996.
4. Uchino O. Scientific Results of the EPIC Projects. 1995.