P1-6

Stratopause Temperature Observation in Bandung, Indonesia (6.9 degree S, 107.6 degree E)

-collaboration between LAPAN. Indonesia and MRI. Japan-

Saipul Hamdi, Sri Kaloka
Indonesian National Institute of Aeronautics and Space (LAPAN)
Jl. DR. Djunjdujnan No. 133 Bandung, Indonesia. Fax : +62-22-637443
Tomohiro Nagai, Akinori Ichiki
Meteorological Research Institute (MRI)
1-1 Nagamine, Tsukuba, Ibaraki 305-0052, Japan, Fax : +81-298-56-0644
Kohei Mizutani, Motoaki Yasui
Communications Research Laboratory (CRL)
4-2-1 Nukui-Kitamachi, Koganei, Tokyo 184-8795, Japan, Fax : +81-423-27-6667
Osamu Uchino and *Toshifumi Fujimoto*
Japan Meteorological Agency (JMA)
3-4, Otemachi 1-Chome, Chiyoda-ku, Tokyo, 100-8122, Japan, Fax : +81-3-3211-4640

ABSTRACT

Observation of temperature profile in Bandung (6.9°S 107.6°E) started on April 1997 under collaboration between LAPAN Indonesia and MRI Japan and continued until now. Under Indonesian weather condition, observation can not be done all of the seasons. Extensive observation can be done in dry season, and only a few numbers of data can be got for in rainy season. The observation will be continued to clarify the long term temperature trend in stratosphere and the shorter period extensive campaign will be held to study the short term variation.

Introduction

Stratospheric temperature is thought to become cooler when the global warming progress, so, it is very important to measure the temperature of stratosphere. Using Raman scatter as well as Rayleigh scatter, it become possible to measure the lower stratosphere even when the aerosol is highly loaded into the stratosphere after large volcanic eruption (Nagai, et. al., 1997).

Hansen et al. (1978, 1992) shows that increase of volcanic aerosol in the stratosphere caused the tropospheric temperature fall through a decrease in short wave radiation due to scattering and absorption. Conversion of sulfur dioxide into sulfuric acid in stratosphere will influence absorption and scattering of sunlight, and then affected atmospheric temperature (Kawamata et.al., 1992)

A lidar was developed to measure the temperature of stratosphere and lower mesosphere, and was transported to LAPAN Bandung, Indonesia in March 1997, and completed the adjusment in September 1997. The transmitter is shared with Communications Research Laboratory (CRL), who constructed the stratospheric aerosol lidar system in the same place. There are different main goals for MRI's and CRL's system. CRL's system can be used to observe aerosol layer for troposphere and stratosphere, and MRI's system can be used for observe temperature profile from tropopause up to 70 km of altitude. We trying to make observation one a week. Since April 09, 1997.

System Description

The lidar transmitter system employ the fundamental wavelength of 1064 nm, second harmonics of 532 nm, and third harmonics of 355 nm transmitted from Nd:YAG laser. Each laser beam is collimated by beam expander and transmitted vertically upward by a plane mirror, respectively. The photons backscattered from the atmosphere are collected by 82 cm diameter telescope. To prevent the strong backscatter signals from near the ground going into detectors, both the high speed 230 Hz rotational chopper and electrical gate circuit are used. The wavelength of the backscattered signals are separated to 3 channels. The first two channels called as "U" and "L" are for Rayleigh scattering of 355 nm. To extend the dynamic range, the Rayleigh signal is separated to two different strength signals. The "U" and "L" means upper and and lower channel respectively. The third channel called as "N" is for vibration Raman scattering of nitrogen molecules of 387 nm wavelength. This channel is used to measure the temperature of the lower stratosphere even if the volcanic aerosol is existing in the layer. Combined with these three channel, we can retrieve the temperature in the entire stratosphere and lower mesosphere. The specifications of the developed lidar system are shown in table 1.

Transmitter

Laser	Nd : YAG
Wavelength	355 nm (3rd harmonics)
Pulse Energy	540 mJ
Repetition	10 Hz
Beam Expander	8 X
Beam Divergence	~ 0.1 mrad
Objectives	Temperature

Receiver

Wavelength	355 nm		386 nm
Scattering	Rayleigh		N_2 Raman
Suppression	N/A		$> 10^{-11}$
Telescope Diameter	82 cm		
Field of View	1 ~ 3 mrad		
Mechanical Chopper	Φ 200 mm , 25 ~ 300 rev/s		
Bandwidth	~ 5 nm	~ 5 nm	~ 5 nm
Transmittance	> 50 %	~ 1 %	> 19 %
Detector	PMT Hamamatsu R331	PMT Hamamatsu R331	Hamamatsu R331

Data Processing

Number of Channels	3
Processing	Photon Counting

Tabel 1. Specification of the newly developed Rayleigh/Raman lidar system.

Results and Discussion

Intensive measurement is started on April 1997. The measurement depends on the weather. The measurement can be done in clear sky condition, only. This condition only true in dry season (April – September). It is very hard to get good data out of this period. Caused by this reason, we can not present so much results.

Figure 1a shows result of measurement on June 16, 1999. Two Rayleigh channel (355 nm and 386 nm) are used to retrieve the temperature profile. There are 2 kinds of profil shown, center of the panel for temperature profile and left side of the panel for statistical error. For statistical error, there are 3 parts of profiles, and for temperature profile there are 3 parts of profile, too. The lower profile of temperature and statistical error correspond to N-channel (12-30 km), the middle profile correspond to L-channel (12-50 km), and the upper profile correspond to U-channel (30-90 km). This measurement is under very clear sky condition in dry season, a half of moon seen on the sky. Temperature profile from U-channel shown in figure 1b, separately, completed by statistical error profile. From figure 1b, it is clear that thickness of stratopause layer is arround 40-53 km altitude. Temperature in this layer does not so fluctuated (similar).

Figure 2 shows variation of temperature inversion in stratopause. Vertical left axis is for temperature inversion (K) and vertical right axis is for height of temperature inversion (km). Horizontal axis is for period of observation, 9704-01 means first week in April '97 and 9906-01 means first week in June '99. The data separated into 3 parts correspond to year '97-'99. Temperature inversion in stratopause is arround 271 K (-2 C) and height of temperature inversion is arround 48 km. It is too early to decide that fluctuation of temperature inversion under nature cycle. It needs very extensive and continous observation.

Figure 3 shows temperature at altitude of 50.04 km. Horizontal axis is for period of observation, and vertical axis is for temperature (K). At this altitude, it can be said that temperature average is arround 262-270 K. Statistical error for this is not more than 2 K. For short term period, it is seen small fluctuation day to day. It is seen clearly in the end of the period of observation (May-June 1999). The highest temperature in this altitude appear on June 06, 1997, reach up to 291.4 ± 0.75 K.

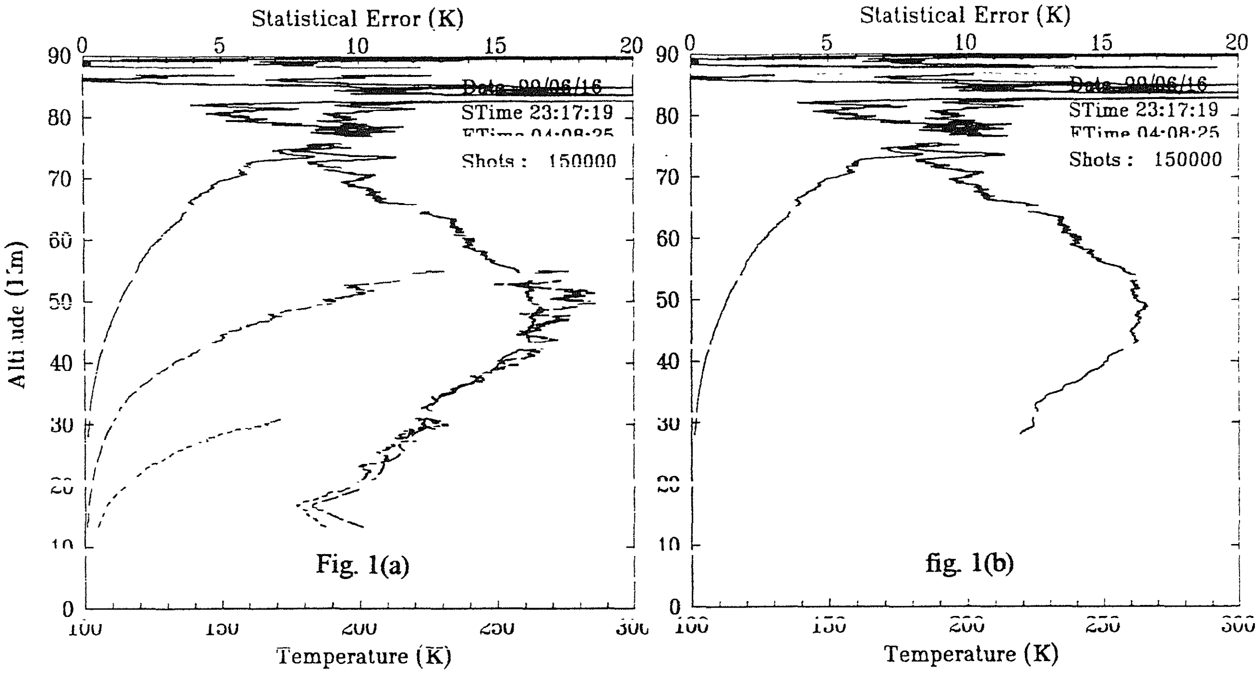

Figure 1. : Temperature profile at June 16, 1999 taken in Bandung. (a) for all system and (b) for upper (U-channel) channel only.

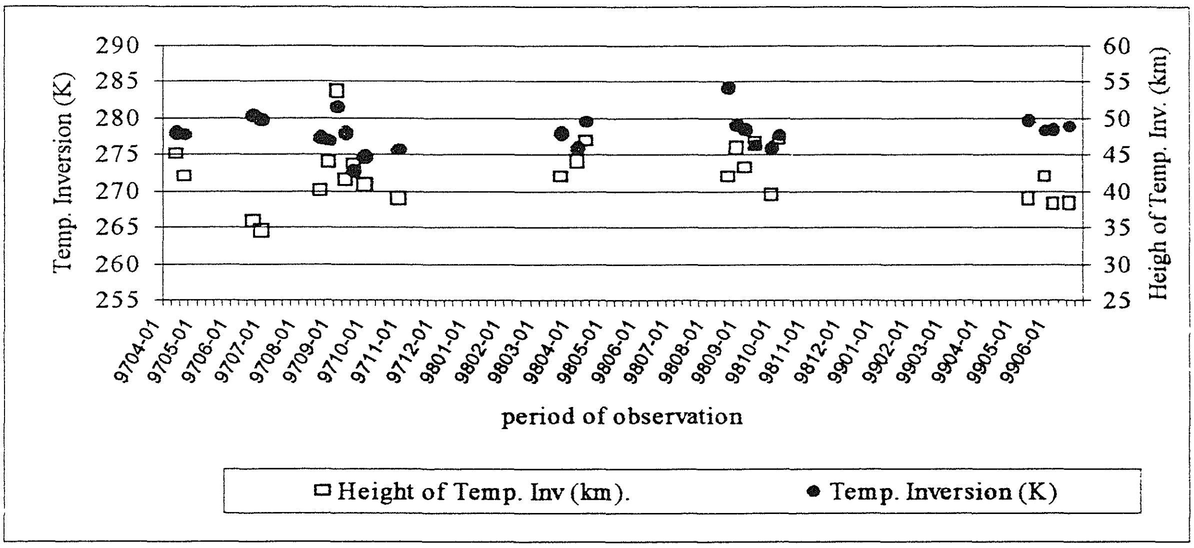

Figure 2. Variation of temperature inversion and height of temperature inversion in stratopause, taken in Bandung, on period of April 07, 1997 to June 18, 1999

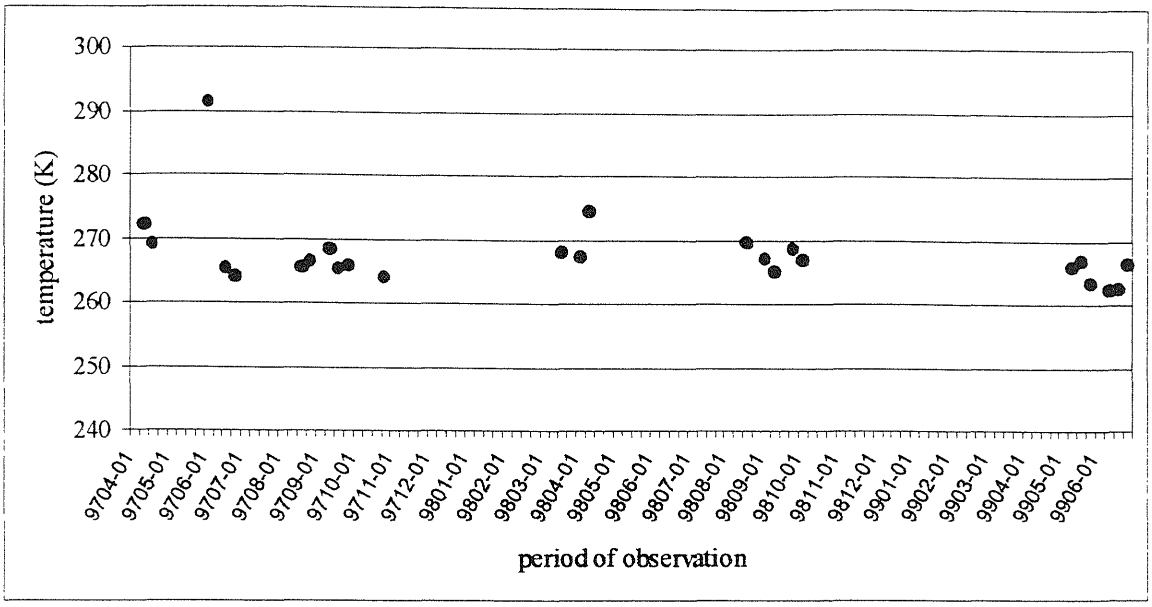

Figure 3. Variation of temperature in altitude of 50.04 km taken in Bandung

Acknowledgments

This work is a part of the "International Cooperative Study on Stratospheric Change and Its Role in Climate" supported by The Science and Technology Agency of Japan (STAJ).

References

1. Hansen, J.E., W.C. Wang and A.A. Lacis, 1978: *Mt. Agung Eruption provides a test of global climatic perturbation*, Science, 199, pp. 1065-1068.

2. Hansen. J., A. Lacis, R. Ruedy and M. Sato, 1992: *Potential climate impact of Mount Pinatubo Eruption*, Geophys. Res. Lett., 19, pp. 215-218.

3. M. Kawamata, S. Yamada, T. Kudoh and K. Takano, 1992: *Atmospheric Temperature Variation After the 1991 Mt. Pinatubo Eruption*, Journal of the Meteorological Society of Japan, Vol 70, No. 6 pp. 110-114.

4. T. Nagai, et.al., : *Lidar Measurement of the Stratospheric Temperature at Bandung, Indonesia*, Proceeding of the Tsukuba International Workshop on Stratospheric Change and Its Role in Climate and on the ATMOS-C1 Satellite Mission, October 20-22, 1997, Tsukuba, Japan.