

S3-2 Observation of Atmospheric Boundary Layer using Lidar System in Jakarta, Indonesia

Mego Pinandito, Imam Rosananto and Santoso Sugondo
Research & Development Center for Calibration Instrumentation & Metrology
Indonesian Institute of Science (KIM-LIPI), Kompleks Puspiptek Serpong Tangerang, Indonesia
Phone 62-21-7560562 ext.3063, Fax 62-21-7560568, E-mail mego@kim-server.ipitek.net.id

Nobuo Sugimoto and Ichiro Matsui
National Institute for Environment Studies, 16-2 Onogawa, Tsukuba 305 Japan
Phone 81-298-50-2459, Fax 81-298-51-4732, E-mail nsugimot@nies.go.jp

1. Introduction

Jakarta is a big city which have high growth of urban population, number of cars and traffic congestion, and industrial activities. These give a significant contribution to the condition of air pollution in Jakarta. Its location is faces to the Java Sea in the north and with highland in southern, means the wind system in Jakarta is a combination of seasonal wind and sea/land breeze. The seasonal wind blows westerly in wet season and easterly in the dry season. This wind is weak during the transition period. Also, Jakarta is in the tropical area, so that there will be much cloud almost in a whole year. The characteristics of clouds in reducing sun radiation and air convection which related to a photochemical reaction are believed give their effects into the air pollution. It is considered that a typical air pollution phenomenon generated by photochemical reactions and transportation of pollutants by sea and land breeze is occurring in Jakarta.

Laser radar system a important tool in order to study the atmospheric environment phenomena such as characteristics of atmospheric layers and clouds which will give their effect to the air pollution and its transportation [1]. We used a lidar network system consisting of two Mie lidars and one differential absorption lidar (DIAL) that was constructed in a cooperative Project of the New Energy and Industrial Technology Development Organization (NEDO) of Japan and the Indonesian Institute of Science (LIPI). This lidar network system had been installed in Jakarta.

In this paper, we report on the measurement of aerosol vertical profile over Jakarta for long time using the lidar network system. The diurnal variation of aerosol profile in different seasons and high altitude cloud affected to the mixed layer were observed.

2. Lidar System

The lidar network system is consisting of two Mie scattering lidar systems and a DIAL system were installed at three different location in Jakarta. They are separated for 10 km approximately by each other, along in line from north to south which is perpendicular to the coastline.

Tabel 1. Specification Mie-scattering lidar

Laser	Compact flash lamp pumped Nd:YAG laser
Wavelength (nm)	1064
Output energy (mJ)	300
Pulse repetition (Hz)	10
Receiver telescope diameter (cm)	25
Field of view (mrad)	0.5 - 2
Filter bandwidth (nm)	9
Detector	Si Avalanche photodiode (APD)
Analog to digital converter (ADC)	
Sampling rate (Msamples/s)	20
ADC accuracy (bits)	12
Measurement mode	vertical

The Mie lidar system employs a compact flashlamp pumped Nd:YAG laser operated at 1064 nm fundamental. The light backscattered from atmosphere was collected by a 25 cm diameter Cassegrainian telescope and detected with a Si avalanche photodiode (APD). A set of neutral density (ND) filter was prepared to prevent saturation of detector for a strong backscattered light. The signal from the APD are recorded with 12 bit accuracy analog-to-digital converter (ADC) and transferred to a personal computer (PC) for real-time display of range-corrected backscattered profiles. For final evaluation, the lidar data is processed on the PC and stored on a harddisk with time, date, and all parameters. In a continuous observation, lidar signals are taken typically for 1000 seconds,

averaged on the PC, and stored on the hard disk. The measurement is continued intermittently typically every 10 minutes. For aerosol measurement, DIAL system is operated as a vertical looking Mie lidar. All lidars are installed in shelter and operated automatically for a long period [2]. Specifications of the Mie lidars are listed in Table 1.

The observation of atmospheric boundary layer had been carried out almost continuously. The data are accumulated typically for 100 seconds (1000 shots) and are taken in every 10 minutes.

3. Observation and results

The results of observation in different period are shown in figure 1, 2 and 3.

We show the range-corrected time-height indication (THI) of the lidar data during December 31 1997 to January 5, 1998 in the figure 1. The depth of gray scale indicates concentration of aerosol. Dark scale indicates high concentration. It showed the typical diurnal variation of the atmospheric boundary layer structure in a wet season up to 6 km. The structure of the boundary layer was complicated. The mixed layers were low in the early morning and began to grow at around 08:00. The

maximum height was at around 12:00 to 14:00, and lower in the evening. On December 31 and January 1, the mixed layer reached the maximum height of 2 km. Also there were high altitude aerosol layer up to 3 km. On January 3, the maximum height of mixed layer exceeded 2 km. It means that the air circulation moves higher than other day.

Figure 2 shows the range-corrected THI of the lidar data from June 14 to 17, 1998. The mixed layers were low in the early morning and began to grow at around 08:00. The maximum height was at around 12:00 to 14:00, and lower in the evening. The maximum height of mixed layer are around 1 km. This structure is different from data in January.

In figure 3, we show the range-corrected THI of the lidar data for October 22 to 26, 1998. This period was in the wet season. We show the typical diurnal variation of the atmospheric boundary layer structure up to 15 km. The depth of gray scale indicates concentration of aerosol. Dark scale indicates high concentration. Here, we can observe higher than in figure 1 and 2. There were almost no clouds at the altitude range up to 9 km on October 23 and 24. The boundary layer was clearly determined.

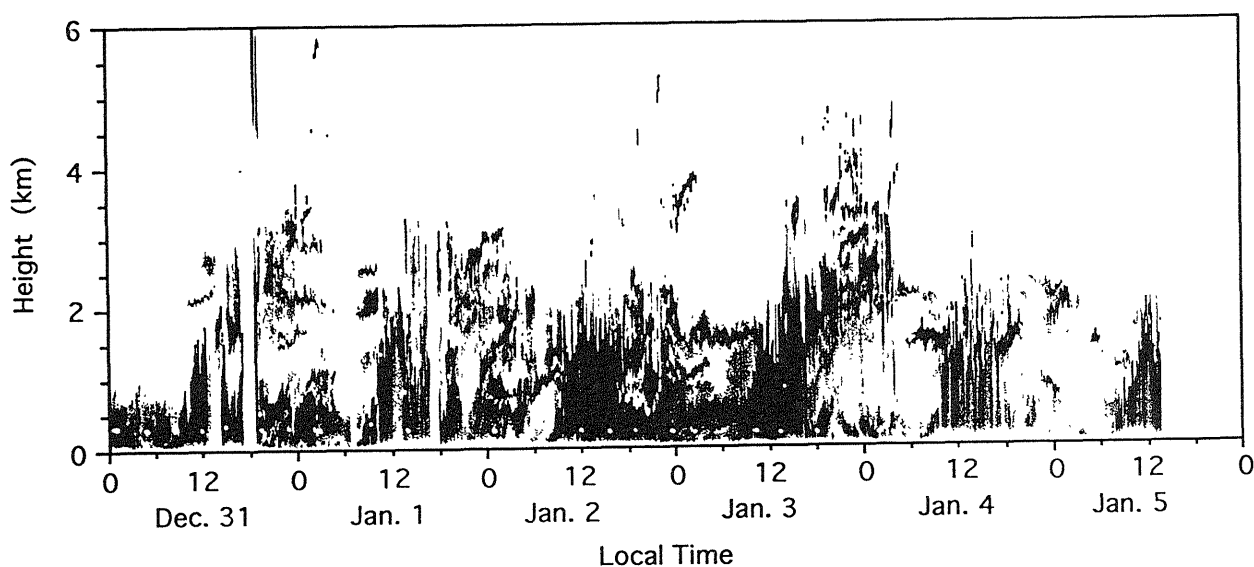


Figure 1. Temporal variation of vertical profile of aerosols during December 31, 1997 to January 5, 1998. Range corrected THI is shown in grey-scale. Dark indicates high concentration.

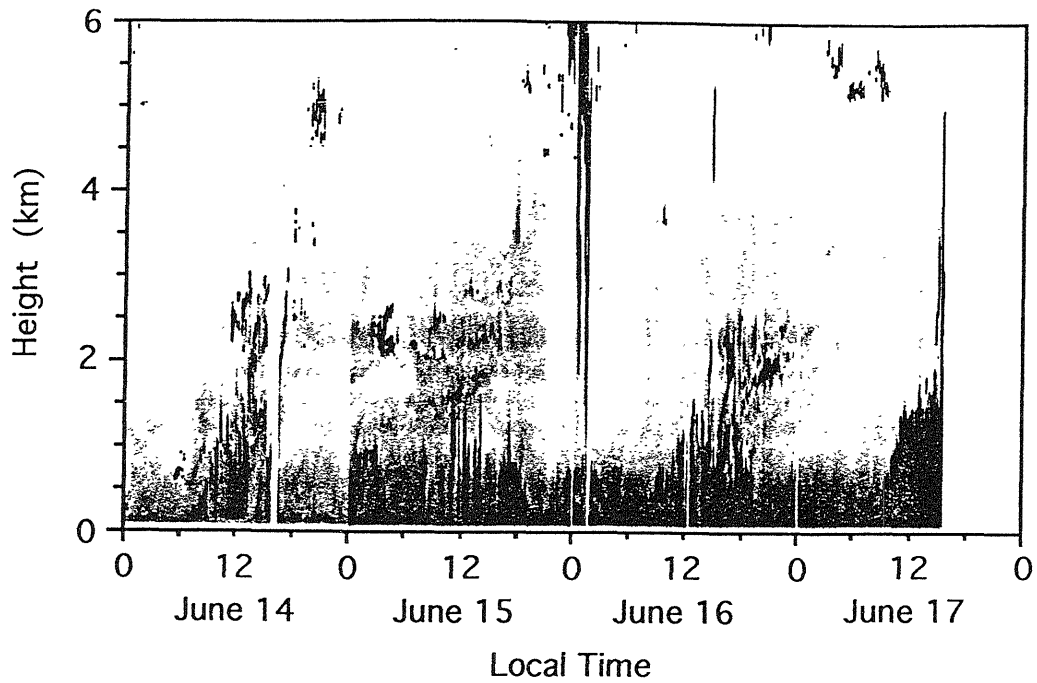


Figure 2. Temporal variation of vertical profile of aerosols during June 14 to 17, 1998. Range corrected THI is shown in grey-scale. Dark indicates high concentration.

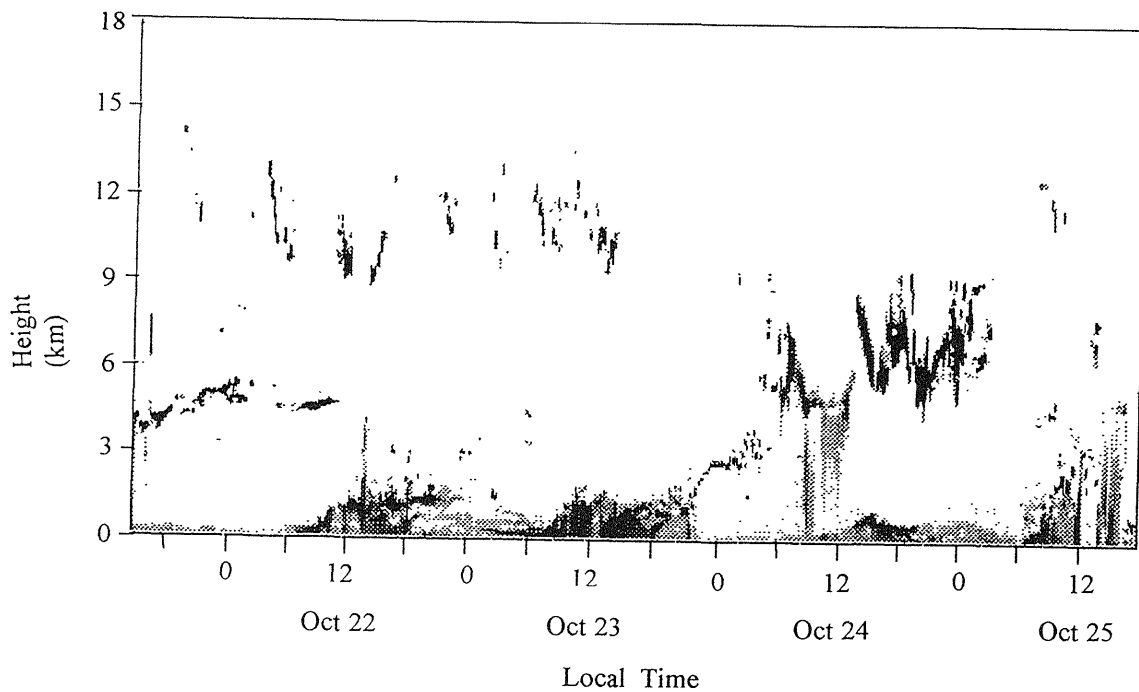


Figure 3. Temporal variation of vertical profile of aerosols during October 22 to 25, 1998. Range corrected THI is shown in grey-scale. Dark indicates high concentration.

The mixed layers were low in the early morning and began to grow at around 08:00.

Maximum height was at around 12:00 to 14:00, when the sun radiation was maximum.

The height of the boundary layer we estimated from the aerosol distributions sometimes exceeded 2 km. In the evening around 17:00, we find a typical layer profile which was changing to two layers. We believed that this phenomena is caused of low aerosol concentrated air blown by a land breeze. On October 25, there were much cloud in altitude of 6 to 8 km and the boundary layer was not clearly determined. Mixed layer were not growing up as high as other day and still have maximum height in 1 km. This phenomena occurred cause of the sunlight was shut out by clouds and thermal radiation from the sun was decreased. It made the air convection which vertically transports the aerosol moved slowly.

4. Summary

The atmospheric boundary layer can be observed using lidar system. The data of vertical aerosol

profile shows the structure of the layer. We found the different structure between wet and dry season. The maximum mixed layer in dry season sometimes exceeded 2 km. It is believed that the seasonal winds give their contribution to this difference. Also clouds which is widely spread in tropical area could affect in shut out the total sun radiation received so that the air convection moves slower. This would cause maximum mixed layer still in height around 1 km. We plan to continue this observation and carry out climatological study using lidar data.

References

- [1] Measures, R.M. (1984). Laser Remote Sensing (John Wiley & Sons, New York).
- [2] Pinandito, M et al., Lidar network system for monitoring the atmospheric environment in Jakarta city, Optical Review Vol.5, No.4, 1998.