２地域における PAL データの比較と浮遊粒子状物質濃度の導出
Comparison of 2 ground-based PAL data and derivation of Suspended Particulate Matter (SPM) Concentration

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Abstract: Portable Automated Lidar (PAL) systems are compact, continuously operating lidar systems for unattended monitoring of the troposphere equipped with an automated realignment system. Data from 2 PAL systems in Chiba University and in Chiba Prefecture Environmental Research Center (CERC), with a distance of approximately 15 km, were compared in this study. Data from the two systems often showed the same cloud events observed at a slightly different time, while the features of the boundary layer were almost the same for all observations. Extinction coefficient derived from the Ichihara system was correlated with a ground based Suspended Particulate Matter (SPM) concentration measurement. The ratio of the mass concentration and extinction coefficient, called the Mass Extinction Efficiency (MEE), changes in the range of 0.1-13m^2/g, with the smaller values occurring when the size distribution is dominated by coarse particles.

1. Introduction

A Mie lidar system is capable of observing atmospheric processes in the troposphere and stratosphere. Continuous operation is especially important for the understanding of the local meteorological phenomena in the area where the lidar is located. The continuous operation of a PAL system can provide a picture of the daily dynamics of the boundary layer and clouds, and comparison of 2 PAL systems from not so distant locations will further verify the atmospheric properties observed by each system.

2. Lidar System

Two PAL systems were used in this study. One of the PAL systems is located at Chiba University (35.60N, 140.10E), 14m above ground level, and the other is placed at the CERC (35.31N, 140.04E), approximately 15km south-west of Chiba University, at about 4.5 m above ground level.

The basic specifications of the PAL systems are summarized in Table 1.

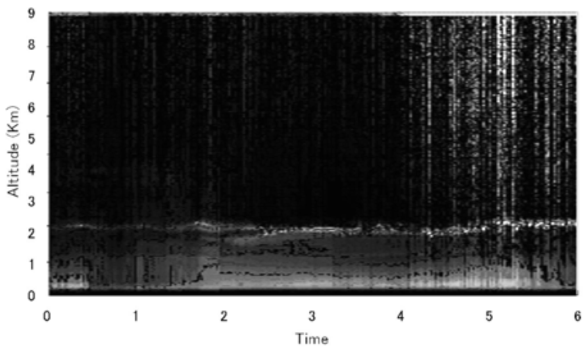
Table 1. PAL System Specification

	Ichihara	**Chiba Univ.**
Configuration	Co-axial 38^0 slant path	Co-axial 90^0 Vertical
Laser	LD-pumped Q-switch Nd:YAG	
Wavelength	532nm	
Repetition rate	1.4 kHz	2.5 kHz
Laser energy	15μJ	
Beam divergence	50μrad	
Receiver		
diameter	20cm	
Type	Cassegrain	
Field of view	0.2 mrad	

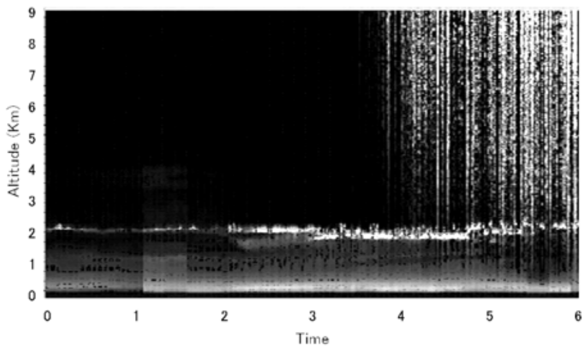
Both systems use a laser diode (LD) pumped Nd:YAG laser for the transmitting part, operating at 532 nm. The output beams of 1mmϕ for the 2 systems are expanded to 25mmϕ before propagating to the atmosphere. Laser pulse energy of 15μJ and repetition rate in the kHz range, which are 3 orders magnitude less and greater than conventional lidar systems, respectively, make the PAL systems virtually eye-safe. Both use a 20cm Cassegrainian type telescope. To reduce the background noise, a narrow field-of-view of 0.2mrad is used. The backscattered signal for both systems is detected by photomultiplier tubes in photon counting mode to further minimize the effects of background noise.

3. Results

The THI maps of the range squared corrected signal for both systems taken on the morning of 12 May 2004 are shown in Fig. 1. Clouds were observed at both sites at around 2km high, double layer clouds can be seen at about 0230H of Fig. 1a) and Fig. 1b) with the slight time delay. This may be attributed to the wind direction at that time towards the east-north-east and north-east, passing through the Ichihara site first then through the Chiba University site. In this case, a cloud capped the boundary layer (BL) (Cloud top BL), which shows a strong backscattering intensity below the clouds probably due to a high relatively humidity. Also multiple layers structure can be seen inside the BL in both figures, where the backscattered intensity decreases at the height of about 500m as shown in the THI and increases again. Both systems showed almost exactly the same BL features.



a)



b)

Fig. 1: Time Height Indication map for a) Ichihara PAL and b) Chiba University PAL system

The extinction coefficient derived from the Ichihara system by Fernald's inversion method was also correlated with a ground based β-ray SPM concentration counter (Shimadzu AAMS-4160A) located about 70m from the lidar site. Whenever the hourly average of the extinction coefficient and the SPM concentration measurement has a correlation coefficient value greater than 70%, a well mixed boundary layer exist. In these cases, the ratio of the mass concentration to extinction coefficient, known as the Mass Extinction Coefficient (MEE), was computed. MEE values range from 0.1-13m^2/g, low values were observed during summer season due to the increase in size of particles because of high humidity and high MEE values were observed when the size distribution is dominated by fine particles, i.e. winter season.

References

1) N. Lagrosas, Y. Yoshii, H. Kuze, N. Takeuchi, S. Naito, A. Sone, H. Kan (2004), Observation of boundary layer aerosol using a continuously operated portable lidar system, Atm. Env., Vol. 38 ,pp. 3885-3892
2) N. Lagrosas, H. Kuze, N. Takeuchi, S. Fukagawa, G. Bagtasa, Y. Yoshii, S. Naito, M. Yabuki, Correlation study between suspended particulate matter and portable automated lidar data (submitted to Atmospheric Environment)