全自動ライダーPAL と NOAA16/AVHRR 画像データによる２地点での雲の観測

Dual site cloud observations by PAL and NOAA16/AVHRR images

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Abstract

Cloud observations by two Portable Automated Lidar (PAL) systems separated approximately 10 km from each other are investigated; Cloud information from visible and infrared channels of NOAA16-AVHRR are then compared with the lidar observations. The PAL, developed by CEReS, Chiba University, is a compact, automated and continuously operating Mie scattering lidar system. Measurements from October 2003 to March 2004 at the two sites show that the similar cloud structures are observed when the wind is along the path of the two sites. Slight differences in cloud occurrence are observed and these time lags correspond well to wind velocity data. The result of the comparison is found to be consistent with the NOAA16-AVHRR images.

1. Introduction

Cloud type, structure and position are important to a lot of meteorological and climatological applications. Clouds have a cooling effect on the earth's surface and knowledge of cloud properties can give us the thermodynamic and hydrodynamic structure of the atmosphere. It may also indicate an inversion layer in the atmosphere[1]. Continuously unaided operation of PAL allowed for long term cloud monitoring without sacrificing the high temporal and spatial resolution.

2. System

The Ichihara PAL[2], located at the Chiba Prefectural Environmental Research Center (35.52N, 140.07E) in Ichihara city, and the Chiba University PAL, located at the main campus of Chiba University (35.62 N, 140.12 E), are used for this study. They are 10 km away from each other and are about 40 km and 30 km southeast of Tokyo, respectively. Figure 1 shows the location map of the 2 sites and Fig. 2 shows the 2 systems. A brief description of PAL is given in Table 1. Both PAL systems are equipped with an automatic realignment system that adjusts laser beam direction every 15 min. to ensure proper system alignment is always maintained.

Table 1: Portable Automated Lidar 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	15mJ	
divergence	50μrad	
Receiver		
Diameter	20cm	
Type	Cassegrain	
Field of view	0.2 mrad	

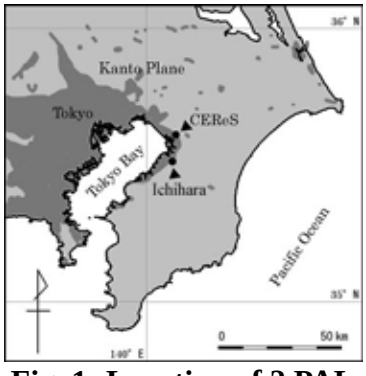


Fig. 1: Location of 2 PAL

The visible (chan.1, 0.50 - 0.68 μm) and thermal infrared (chan.4, 10.3-11.3 μm) channels of Advanced Very High Resolution Radiometer (AVHRR) on board the NOAA16 satellite is used in classifying the cloud types. The data from PAL are used to verify the satellite data. Cloud type classification

done in this study is based on split-window measurement of AVHRR using a threshold technique in the 2-D histogram of the brightness temperature of chan.4[3]. Table 2 shows some of the characteristics of NOAA16-AVHRR.

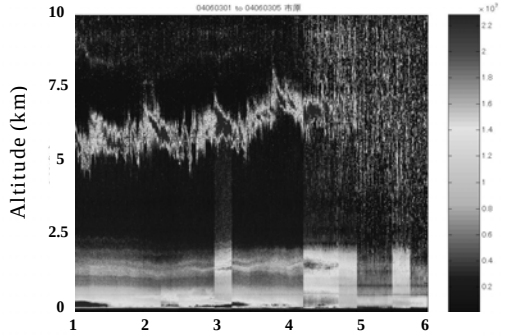
Table 2: NOAA-16 Specification

Orbital characteristics	
Orbit inclination	98.8 deg
Mean altitude (km)	851
Equator crossing time	Northbound 13:54A Southbound 1:54D
Period (min.)	102.1
AVHRR characteristics	
resolution	1.1 km
Swath width	3000 km
Spectral range / IFoV	
Channel 1 (visible)	0.50 - 0.68 μm / 1.39mrad
Channel 4 (infrared)	10.3-11.3 μm / 1.41 mrad

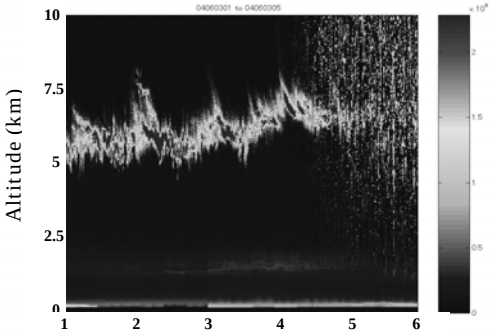
3. Results

Figures 2 a) and 2 b) show the Ichihara and Chiba University PAL data for 3June2004 from ground to 6 km in height, respectively. Figure 2 c) shows the cloud type classification map of NOAA where white indicates cumulus clouds, dark gray for cirrus, light gray for dense cirrus and black for unclassified or cloud free area. And Fig. 2 d) is the visible channel image of NOAA. The clouds in PAL data are found in about 5 – 7 km, due to the orientation of the systems, at this altitude both PAL are actually observing about the same volume, thus the cloud structure in the graphs are almost identical. The observed clouds have downward streaks indicative of falling cloud particles (i.e. heavy ice particles) and low optically depth of about 0.75 (1.5 km thickness), we can therefore say that we are observing mid-altitude cirrus clouds.

Figures 2 c) and d) verify that there are clouds present, and the resulting cloud type are cirrus (dark gray) and dense cirrus (light gray).

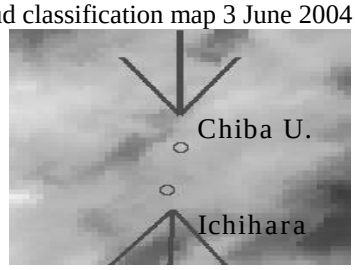


a) Ichihara PAL data 3 June 2004 0100-0500H



b) Chiba U. PAL data 3 June 2004 0100-0500H

c) cloud classification map 3 June 2004 0300H



d) visible channel image 3 June 2004 0300H

Fig. 2 Data on 3 June, 2004 of two PAL's and AVHRR

4. Conclusion

This study shows very similar cloud behavior between the 2 PAL observations even with the 10 km separation. In addition, the PAL observations can verify the cloud typing method using NOAA-AVHRR images. Moreover, time lag of cloud occurrence for two sites and wind speed appear to be consistent with wind velocity data. More results will be shown at the presentation.

5. References

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