MONITORING OF AEOLIAN DUST USING JMA OPERATIONAL LIDAR UNDER THE FRAMEWORK OF WMO/GAW AEROSOL OBSERVATION NETWORK

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ABSTRACT

The Japan Meteorological Agency (JMA) has started continuous lidar operation on March 2002, to observe vertical profile of aerosols. With this lidar system, we can monitor not only tropospheric aerosols but also stratospheric aerosols 6 hourly. Up to now, we could detect aeolian dust, biomass burning smoke and stratospheric aerosol, which was injected by the eruption of Mt. Reventador (Ecuador) on November 2002.

In this paper, we show a typical case of aeolian dust event. The time series of dust profiles and its comparison with the simulated dust concentration by JMA/CTM (Chemical Transport Model), which is run routinely for forecasting aeolian dust, are presented.

1. INTRODUCTION

The optical characteristics and the horizontal / vertical distributions of aerosols are one of the largest unknowns on the climate change forecast. The World Meteorological Organization (WMO) thus recommended to promote global watch of aerosols in the Global Atmosphere Watch (GAW) project [1]. And the operational aerosol lidar system had been developed by the Meteorological Research Institute (MRI) through the long term studies of El Chichon / Pinatubo volcanic eruptions and Aeolian Dust Experiment on Climate impact (ADEC) projects [2][3][4]. With this background, JMA decided to set up new aerosol lidar system to the Atmospheric Environment Observatory, which is located in the northeastern part of Japan and is one of the regional GAW stations, in addition to the observation of aerosol optical depth using sunphotometer. Then, continuous lidar operation began on March 2002.

The operational JMA lidar system can monitor various aerosols of the troposphere and the stratosphere. In this paper, we introduce an observational result of mineral dust aerosol transported from the Asian continent. Firstly, the characteristics of the lidar system and an example of tropospheric aerosol observations will be introduced. Secondary, the comparison between the results of time-cross sections of dust derived from lidar observation and the dust forecasting model will be shown.

2. CHARACTERISTICS OF THE LIDAR SYSTEM

The characteristics of the JMA operational lidar system are shown in Table 1.

Table 1. The characteristics of JMA operational lidar system

Transmitter	
Type	Flashlamp pumped Q-switch Nd:YAG
Wavelength (nm)	532
Pulse energy (mJ)	300
Pulse repetition (Hz)	10
Beam divergence (mrad)	0.12

Receiver	Lower atmosphere	Upper atmosphere
Telescope diameter (mm)	280	355
Field of view (mrad)	0.3-3.0	0.3-3.0
Polarization	P and S	P and S
Raman wavelength (nm)		607
Filter bandwidth (nm)	0.5	0.5
Photomultiplier tube	R3234-01 (@532 nm)	R3237-01 (@607 nm)

Signal Processor	Analog	Photon counting
Sampling rate (MHz)	20	20
A/D resolution	12 bit	

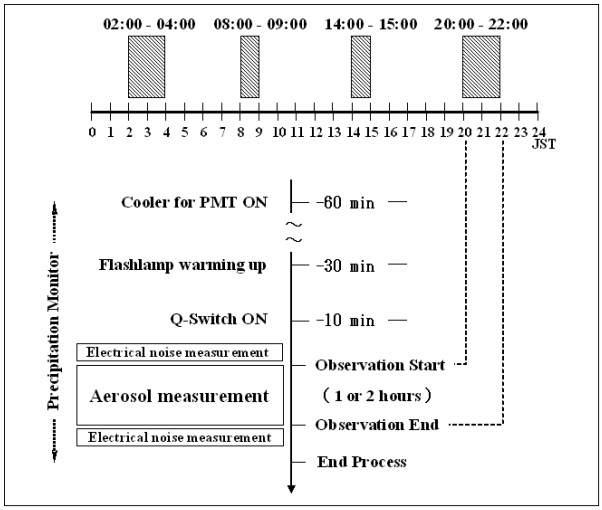

Fig.1. Operation schedule of JMA lidar.

Vertical distributions of the backscattering ratio and the depolarization ratio at 532nm are regularly calculated. The extinction coefficients and lidar ratios can be obtained using Raman scattered signals, although it is limited in the free troposphere under fine weather nighttime condition. The operation is made one in six hours as shown in Fig.1.

3. RESULTS AND DISCUSSION

The Asian dust event ”KOSA” was observed at many observatories in the west and north part of Japan from 16th to 21st April 2004. Fig.2 shows the time cross section of dust concentration above the Atmospheric Environment Observatory, calculated by JMA Chemical Transport Model (CTM) during this event. The backscattering ratio and the depolarization ratio by JMA lidar are also shown in Fig.2.

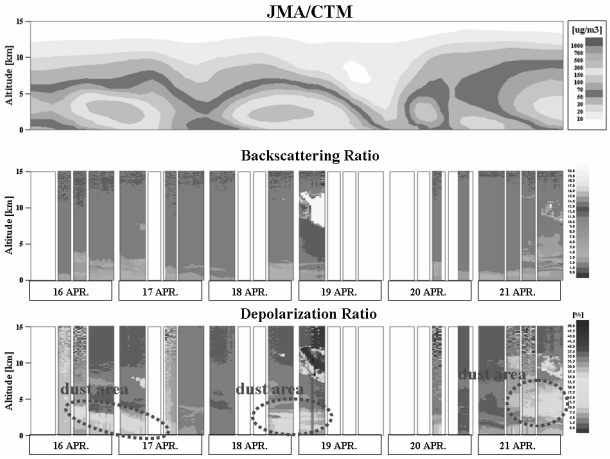

Fig.2. Comparison of lidar observational results with the JMA/CTM result.

From lidar observational results, three dust events, 16th-17th, 18th-19th and 21st, are detected. The vertical area and the periods of higher dust concentration calculated by CTM are similar to the depolarization ratio profile observed by the lidar.

We tried to classify 4 types of aerosol species from the backscattering and depolarization ratios of lidar signal. The thresholds of the backscattering ratio and the depolarization ratio for classification are shown in Fig.3. This classification is very rough, but an easy way to remove cloud or spherical aerosol signals. In Fig.4, the result of model calculation is superimposed on the image, which picked dust area from the result of the classification.

The dust distribution obtained by lidar signal matched quite well with that of model simulations (Fig.4). In this event, it seems that dust is detected in the area of about 200μg/m^3 of the CTM calculation.

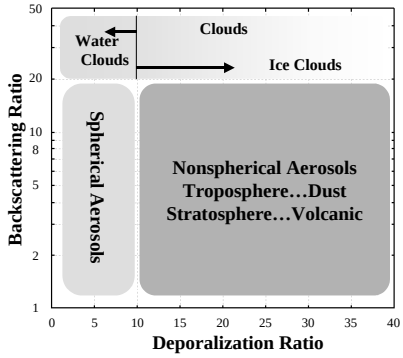

Fig. 3. Pattern matching definition of aerosol types.

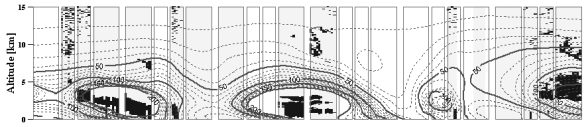

Fig. 4. Model calculation result was superimposed to lidar observation result. Black area is the result of classification to dust, contours are the result of the CTM calculation.

Through the classification of lidar signals and the comparison with model calculation, we showed feasibility on aeolian dust detection using the JMA lidar data. We are going to make more statistical studies on setting thresholds for aerosol classification and going to use the lidar data for CTM verification.

JMA operational lidar data are open for scientific community. They are archived into “Annual Report on Atmospheric and Marine Environment Monitoring (CD-ROM)”. Also, we plan to send lidar data to the World Data Centre for Aerosols (WDCA) in near future.

4.REFERENCES

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