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Lidar System for Research Ship Mirai

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1.Introduction

The height distributions of PBL, aerosols and cirrus clouds in the Pacific ocean region are the very important information in order to understand the global radiation budget and the interaction between the atmosphere and the ocean.

In a past decade, only few lidar soundings have been made for those in this region, i.e. Global Backscatter Experiment (GLOBE) missions in 1989 and 1990[1], and PEM-West B(Pacific Exploratory Mission) in 1994[2]. These campaigns have been made by using the lidars and in situ instruments, e.g. optical particle counters, particle impactors, equipped in NASA DC-8 research aircraft.

In Japan, Japan Marine Science and Technology Center (JAMSTEC) under contract of Science and Technology Agency (STA) has been operating the research ship "Mirai (8,800 tons displacement)" for studies of oceanography and atmosphere from the end of 1998. Three two-months campaigns per year in the western Pacific Ocean region were scheduled for three years from 1999. We developed the shipborne backscatter lidars in order to participate these campaigns. The primary objectives are not only to take height distribution data of PBL, aerosols, cirrus cloud with dependencies of the longitude and the latitude for improving our knowledge of atmospheric circulation and climate dynamics, but also to support NASDA's spaceborne lidar projects, Mission Demonstration Satellite (MDS) –II "ELISE" mission[3], and the ISS Japanese Experiment Module (JEM)/CDL mission[4].

In this paper, we would present our shipborne lidar system and preliminary experimental results obtained in the western Pacific ocean in February-March, 1999[5]

Laser	Flash lamp pumped Nd:YAG laser
Output energy	100mJ per pulse at 1.06μm
	50mJ per pulse at 532nm
Repetition rate	10Hz
Telescope	Schmidt Cassegrain
Diameter	28cm
Field of view	1mrad
Detector	Si-APD for 1.06μm/PMT for 532nm
Detection	Analog, 3channels
	(1.06μm, 532nm-parallel, 532nm-normal)
Digitizer	8bits

Table 1 Specification of shipborne lidar.

2.Lidar system

A design concept of the shipborne lidar is featured as follows, the depolarization observation of clouds with angular dependence , wavelength dependence of the aerosols in PBL so on. A specification of lidar system is shown in Table 1. The laser transmitter is based on a Nd:YAG laser running 50mJ per pulse at 532nm and 100mJ per pulse at 1.06μm, with 10Hz of repetition rate. The receiving telescope is a Schmidt Cassegrain type with a diameter of 25 cm. The back scattered signals collected by the telescope are separated into 3-channel through the polarized beam splitter and then fed to two PMTs and the Si-APD. Each output from these detectors are digitized with sampling rates of 40 nsec. by a 3 channels A/D converter (LeCroy Inc., LC574AL). Digitized data are processed with 10-shots averaging in the personal computer (IBM Inc., PC 300PL) to achieve the maximum observable height of up to 24km at 532nm-channels and that of up to 6km at 1.06μm-channel. In addition, the clinometer was set on the optical bench close to the receiving telescope in order to measure pitching angle and rolling one at every 1 sec. The data from the clinometer are used in the analysis of angular dependency for the depolarization of cirrus and in the calibration of accurate optical axis for the transmitting and receiving optics. The system has been automatically operated during the first campaign. Whole system was installed in an air-conditioned lidar container (Fig.1) with the

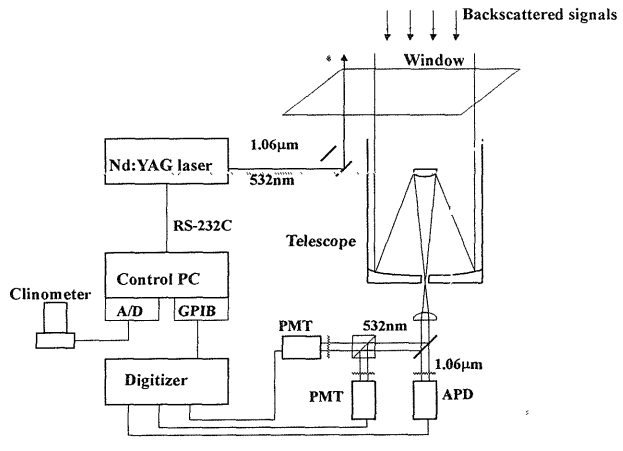

Fig.1 Shipborne lidar system installed in the container.

size of 4m(L)×2m(W)×2.5m(H) and set on aft deck of the "Mirai".

3.Experiment

The first lidar experiment was carried out in February-March, 1999 in the Western Pacific Ocean region. Fig.2 shows the Mirai's route in this campaign. During the campaign, as we expected, we often had problems with contamination of an optical window on the top of container caused by spray. So we had to wipe it away every one hour to avoid the attenuation of transmission for the window.

The preliminary experimental results are shown in Fig.3. These were obtained in the region 0N – 8N (dotted enclosure in Fig. 2). The top figure indicates the THI for the p-component at 532 nm. It is obvious that the height of PBL is mostly about 1000 m. Cirrus clouds were frequently measured in the height range of 10 km-16 km. The bottom figure shows depolarization effect of cirrus clouds calculated by using the above data and that for the s-component at 532 nm. From this result, most cirrus clouds seem to consist of ice crystals compared with lower clouds.

4.Conclusion

The shipborne lidar system and preliminary result in the west Pacific Ocean were discussed. At present, the second campaign, called as Nauru mission, has been carrying out for 40 days from the beginning of June, 1999. We will also report about the data of this Nauru mission.

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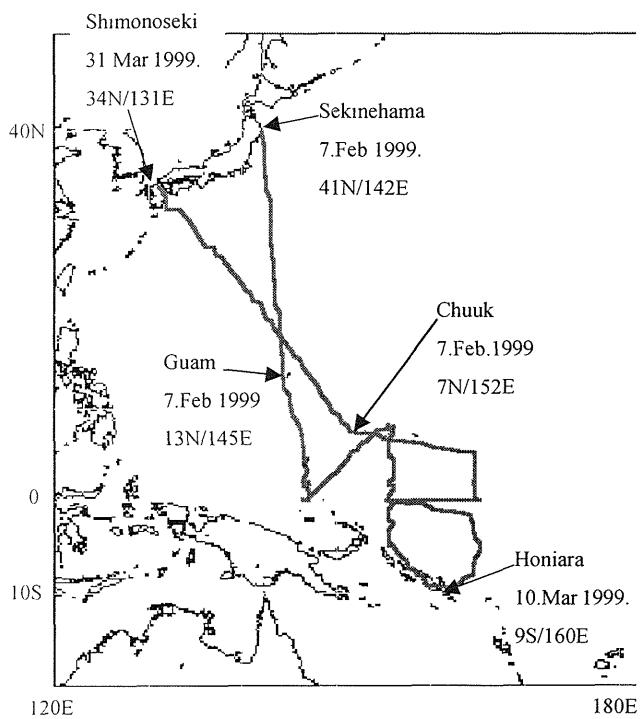

Fig.2 The route of MR99-K01.

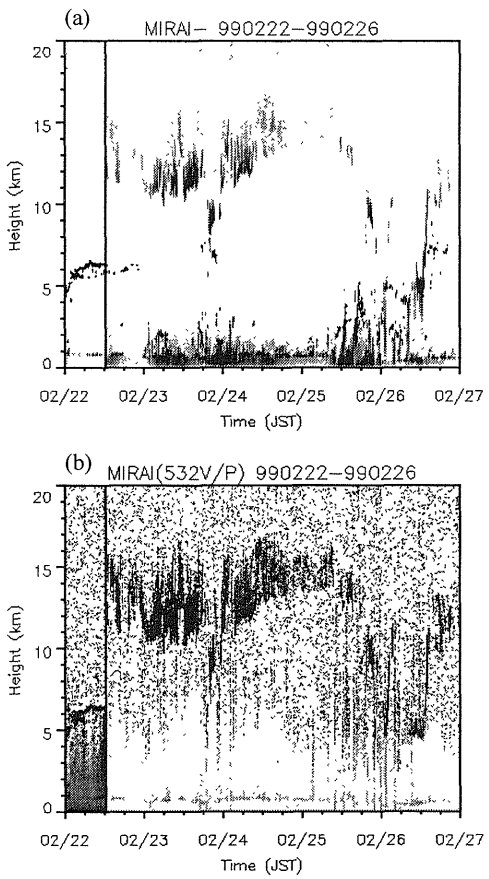

Fig.3 Time-height indication of (a) lidar backscatter intensity and (b) depolarization at 532nm, observed between February 22 and 27, 1999.