P 1.6 POLARIMETRIC INVESTIGATION OF AEROSOL AND CIRRUS CLOUD OVER THE OCEAN

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1. INTRODUCTION

The Polarization and Directionality of the Earth's Reflectances (POLDER) on board the Advanced Earth Observing Satellite (ADEOS) was launched by the National Space Development Agency of Japan (NASDA) in 1996. The POLDER instrument observed the polarization, directional and spectral characteristics of the solar light reflected by aerosols, clouds, oceans and land surfaces. To validate the results derived from the satellite data, ground-based measurements were carried out over the ocean (Masuda and Sasaki, 1997).

Masuda et al. (1999) investigated the feasibility of polarization measurement by instruments on board satellites to retrieve the aerosol optical properties over the ocean. They retrieved the aerosol optical thickness and Ångtsröm exponent from the polarization measurement by referring to a look-up table. Sasaki et al. (2000) applied this algorithm to investigate aerosol optical properties from observations made on board the R/V MIRAI operated by the Japan Marine Science and Technology Center (JAMSTEC) in the western equatorial Pacific Ocean during Nauru99 (DOE/ARM).

In this paper, we describe optical properties of aerosols derived from polarization measurements during Nauru99. Furthermore, we investigated the feasibility of retrieving thin cirrus cloud optical properties over the ocean using polarization measurements. We also compared the sky radiation measured with numerical results from radiative transfer calculations.

2. DESCRIPTION OF INSTRUMENT

A multi channel polarimeter (FPR-5000) was used to measure the radiance and degree of polarization of skylight. FPR-5000 is briefly described in Table 1. It has six interference filters whose wavelengths correspond to those of POLDER and the Ocean Color and Temperature Scanner (OCTS) sensors on board ADEOS. It is controlled by a tracker unit that automatically points and adjusts the directions to the solar direction and other scattering directions.

3. RADIATIVE TRANSFER CALCULATION

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Table 1 Characteristics of FPR-5000

Channel	Wavelength (band width)
0	dark
1	443.7 nm (16.7nm)
2	489.5 nm (19.0nm)
3	563.0 nm (24.0nm)
4	667.3 nm (17.1nm)
5	760.0 nm (36.0nm)
6	860.5 nm (43.0nm)

Detector: Silicon photo diode (5.8*5.8mm)
Temperature stabilizer: Peltier junction device
Polarizer: Glan Thompson prism
(rotated by stepping motor)
(0.9 deg. Step)
Field of view: 2 deg.

The degree of polarization in the principal plane is obtained by radiative transfer calculations, in which cirrus clouds are assumed to contain randomly oriented hexagonal ice crystals (Table 2). Single scattering optical properties for ice clouds are computed using the geometrical optics approximation method (Masuda and Takashima, 1997). The radiative transfer calculations were based on the doubling-adding method. A vertically inhomogeneous atmosphere is simulated by four homogeneous sub-layers (0 to 2Km, 2 to 6Km, 6 to 13Km, 13 to 100Km). The cirrus cloud is assumed to be homogeneously concentrated in the third layer (6 to 13Km). The background aerosols are excluded. The optical thickness of molecular scattering and absorption are obtained from LOWTRAN7 (Kneizys et al. 1988). The ocean surface is simulated by multiple facets whose slopes vary according to the wind speed over the ocean (Cox and Munk, 1954). The wind speed is assumed to be

Table 2 Dimensions of ice crystal particle model

Model	2R(µm)	L (µm)	L/2R
V1	16.88	48.22	1.43
V2	33.67	96.20	1.43
V3	55.52	254.57	2.29
V4	89.86	666.70	3.71
V5	144.34	1720.23	5.96

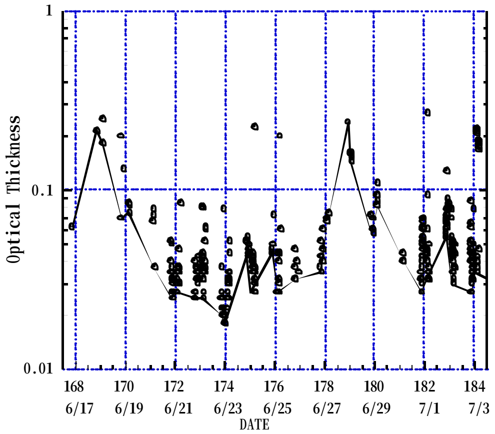

Figure1 The aerosol optical thickness during Nauru99 retrieved from the polarization

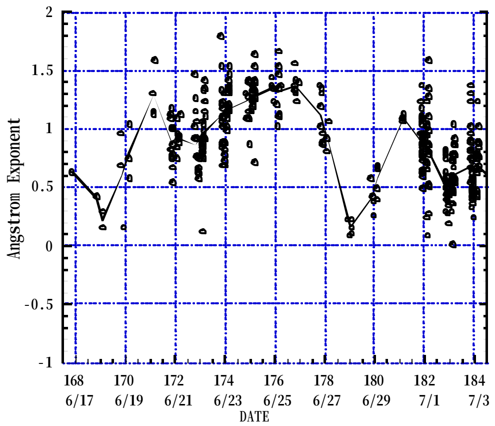

Figure 2 The Ångström exponent during Nauru99 retrieved from the polarization

5m/sec.

4. RESULTS AND DISCUSSION

The aerosol optical thickness retrieved from the polarization measurement during Nauru99 is plotted in Figure1. The solid line denotes the minimum values in a half day to remove the effect of cloud contamination. The aerosol optical thickness is very low (about 0.03) from June 21 to 27. After the shower on June 27, the optical thickness became larger (0.04 to 0.08).

Figure 2 is the same as Fig 1 but for the Ångström exponent. The solid line denotes the average value of the Ångström exponent in a half day. The Ångström exponent retrieved from polarization measurement was 0.2 to 1.3. After the shower on June 27, the Ångström exponent became smaller. This suggests that a large number of bigger aerosol particles existed on June 27.

Figure 3 shows the degree of polarization at two

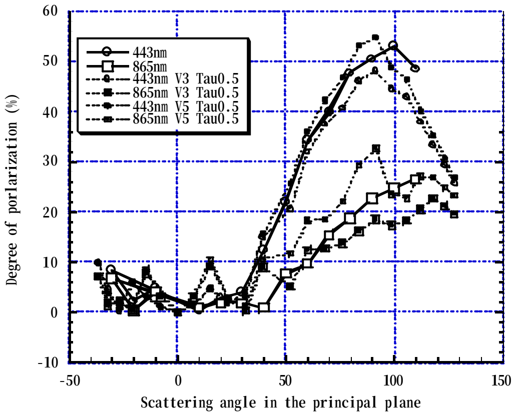

Figure 3 Degree of polarization as a function of scattering angle in the principal plane

wavelengths (443nm and 865nm) as a function of scattering angle in the principal plane. Solid lines denote measurement values, whereas dotted lines denote the calculations. Medium marks and small marks denote V3 and V4 crystal particle models. The measured and calculated degree of polarization correlate well at scattering angles of less than 90 degrees.

5. CONCLUSION

We compared the sky radiation measured with numerical results from the radiative transfer calculations and found polarization measurements to be useful for retrieving optical properties of thin cirrus clouds.

6.REFERENCE

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