The analysis of Skyradiometer observation data by using SKYRAD.PACK and MRI-MLM

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Abstract

SKYNET is the aerosol-cloud monitoring network in East Asia which uses PREDE skyradiometer. The aerosol optical properties which skyradiometer observes are retrieved by SKYRAD.PACK in SKYNET. We developed the software (MRI-MLM) to apply the inversion method to the maximum likelihood method based on SKYRAD.PACK version 4.2. We analyzed skyradiometer data observed in Tsukuba, JAPAN by using SKYRAD.PACK and MRI-MLM, and investigate the difference of retrieved results.

Keywords **:** skyradiometer, SKYNET, aerosol, maximum likelihood method

1. Introduction

Aerosol optical properties are very important in the studies of global and regional climate changes. SKYNET (Nakajima et al., 2003) ground based observation network is well known aerosol-cloud monitoring network in East Asia which uses skyradiometer (POM-01 or POM-02 manufactured by PREDE Co., Ltd.) for the purpose of aerosol radiative forcing studies. The aerosol optical properties which skyradiometer observes are retrieved by SKYRAD.PACK (Nakajima et al., 1996).

We improved SKYRAD.PACK version 4.2 and developed software (MRI-MLM) to apply the inversion method to the maximum likelihood method (Kobayashi et al., 2006). In this study, we compare the aerosol optical properties retrieved by using SKYRAD.PACK and MRI-MLM, respectively.

2. Skyradiometer observation data

PREDE skyradiometer POM-02 was installed and started observation in 2002 at Meteorological Research Institute (MRI) in Tsukuba (36.056N, 140.125E), Japan. Skyradiometer has been calibrated by inter-comparing it to the spetctoradiometer (SVC GER2600 manufactured by Spectra Vista Co., Ltd.) in every winter season. The spectroradiometer was calibrated annually by the Langley method using the data obtained at Mauna Loa Observatory (MLO), NOAA ESRL-GMD.

2. Data analysis

We analyzed skyradiometer data observed at MRI from 2004 to 2010 by using SKYRAD.PACK version 4.2 and MRI-MLM version 1.1, respectively. The analysis of skyradiometer needs the total ozone amount and the surface pressure to take account of ozone absorption and Rayleigh scattering of air molecules. The monthly averaged total ozone amount for 39 years (from 1971 to 2009) is taken from Aerological Observatory close to MRI. The surface pressure is taken from SYNOP data from same site.

The cloud affected data was detected by CSSR version 1.0 (Khatri and Takamura, 2009).

3. Intercomparison of aerosol optical properties

The intercomparisons of aerosol optical properties at wave length 400, 500, 675, and 870nm between SKYRAD.PACK and MRI-MLM were based on 12594 retrieved data. Figure 1 (a), (b) and (c) show scatter plots of aerosol optical thickness (AOT@500) at wavelength 500nm, Ångström exponent and single scattering albedo (SSA@500) at wavelength 500nm, respectively. AOT@500 has significant linear relationship (R=0.99, Slope=0.99, Intercept=0.01) between SKYRAD.PACK and MRI-MLM. There is good linear correlation for Ångström exponent between them. On the other hand, the retrieved single scattering albedo SSA@500 is little dispersed. $SSA@500_{MRI\text{-}MLM}$ is underestimate in the case of $SSA@500_{SKYRAD.PACK}>0.86$ and $SSA@500_{MRI\text{-}MLM}$ is overestimate in the case of $SSA@500_{SKYRAD.PACK}<0.86$, respectively.

Linear correlations of aerosol optical thickness, single scattering albedo, and Ångström exponent between SKYRAD.PACK and MRI-MLM are shown in Table 1. Aerosol optical thickness at each wavelength has highly significant linear relationship with correlation coefficient lager than 0.99 between SKYRAD.PACK and MRI-MLM. Calculated Ångström exponents by the results of MRI-MLM are similar to those of SKYRAD.PACK. Correlation coefficients of single scattering albedo at all wavelengths are little dispersed. Single scattering albedo from MRI-MLM ($SSA_{MRI-MLM}$) is underestimate in the case of that of SKYRAD.PACK($SSA_{SKYRAD.PACK}$) is larger than around 0.87 at each wavelength and $SSA_{MRI-MLM}$ is overestimate in the case of $SSA_{SKYRAD.PACK}$ is less than around 0.87 at each wavelength , respectively.

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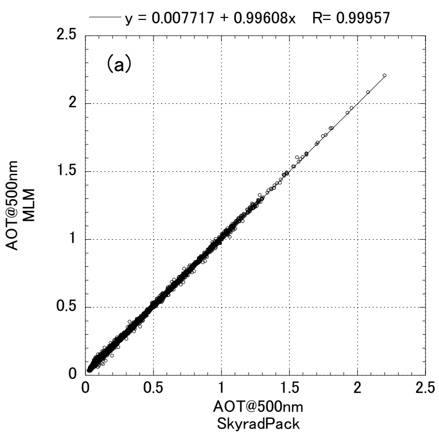

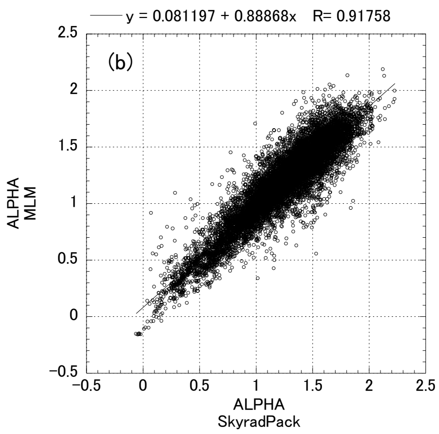

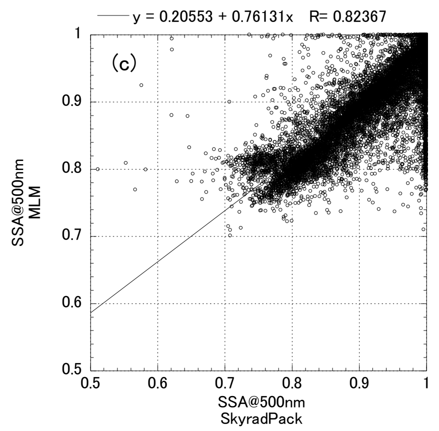

Fig. 1. Scatter plots of aerosol optical thickness (AOT) at wavelength 500nm (a), Ångström exponent (ALPHA) (b), and single scattering albedo (SSA) at wavelength 500nm (c) between SKYRAD.PACK and MRI-MLM.

Table 1. Regression curves coefficients of aerosol optical thickness (AOT), single scattering albedo (SSA), and Ångström exponent (ALPHA) between SKYRAD.PACK and MRI-MLM.

	Slope	Intercept	R
AOT@400	0.986	0.005	0.999
AOT@500	0.996	0.008	1.000
AOT@675	0.996	0.007	0.998
AOT@870	0.996	0.007	0.998
SSA@400	0.793	0.180	0.833
SSA@500	0.761	0.206	0.824
SSA@675	0.724	0.236	0.818
SSA@870	0.663	0.300	0.744
ALPHA	0.889	0.081	0.918