An investigation of SSA retrieval using simulated SKYNET observations

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Abstract

Single scattering albedo (SSA) is a key parameter to estimate aerosol direct radiative forcing and to understand earth's climate. This study focused on SSA retrieval by a software package, SKYRAD.pack, which has been developed by University of Tokyo but shown a tendency of overestimates of retrieved SSA suggested by comparison with AERONET results in Beijing. In order to investigate the origins of the errors, we did sensitivity tests for various parameters (ground albedo, calibration constant, gas absorption) associated with the algorithm program in SKYRAD.pack. The results showed that overestimate of retrieved SSA is attributed by underestimate of calibration constant and/or ground surface albedo. The consideration of gas absorption is not a possible reason of the error but an important step for SKYRAD.pack to more accurately retrieve SSA.

Keywords **:** SSA; SKYRAD.pack; algorithm

1. Introduction

Aerosol optical properties observed by SKYNET are retrieved using a software package, SKYRAD.pack, developed by the University of Tokyo. However, it has been pointed out that the value of the single scattering albedo (SSA) in Beijing site was systematically larger than that of AERONET (Che et al., 2008). A close intercomparison of the SKYNET and AERONET results indicates that SSA from SKYNET has a tendency to rapidly become unity with increase in wavelength, when SSA value is close to unity. And there is also a tendency of larger size distribution for coarse mode aerosols with radius larger than several microns. The same happened in Phimai observation site (Tsuruta, *personal communication*, 2010).

There are several candidates for the cause: Ignorance of gaseous absorption by SKYRAD.pack; the minimum observable scattering angle (3 degrees) is not small enough for retrieving the coarse mode aerosol size distribution; error in the improved Langley method (Nakajima et al., 1996); error in the solid angle measurement and so on. We, therefore, made a numerical experiment using the Rstar6b radiative transfer code to simulate observed data of PREDE skyradiometer and investigate the effects of various observational and instrumental parameters that affect the SKYNET retrievals.

2. Methods

Observation data was simulated by the radiation model assuming the gaseous constituent profiles of "US standard atmosphere" and the optical properties of "Rural aerosol type" with a solar zenith angle of 60 degree, and ground surface albedo of 0.2. The rural aerosol type includes water-soluble (70 %) and dust-like particles (30 %). We used five channels at 400, 500, 670, 870, and 1020 nm. In the analysis, we gave normal random errors of ±5%, ±10%, and ±50% to the ground surface albedo and ±1%, ±3% and ±5% to the calibration constant for the test data to be analyzed by SKYRAD.pack. We also changed the minimum observable scattering angle from 1.5 to 3 degrees. Furthermore, we made experiments with and without gas absorption in the inversion.

3. Results and Conclusions

From Figs. 1 and 2, SSA was overestimated when the calibration constant or ground surface albedo given in the analysis was lower than in reality. Particularly, a small difference in the calibration constant had a significant impact on the SSA retrieval. It was also found that the smaller minimum observable scattering angle improved the retrieval of the volume size distribution for large particles (*not shown*), but the retrieved SSA rarely changed its value. From Fig. 3, SSA was improved when gas absorption is included in the analysis, but the improvement is small and difficult to explain the large difference in the retrieved SSA values between SKYNET

and AERONET. That is, it is considered that a cause of large SSA in Beijing is underestimate of calibration constant and/or ground surface albedo. In the future study, we will investigate impacts of other candidates to retrieved SSA, especially in terms of the differences in SSA between different wavelengths.

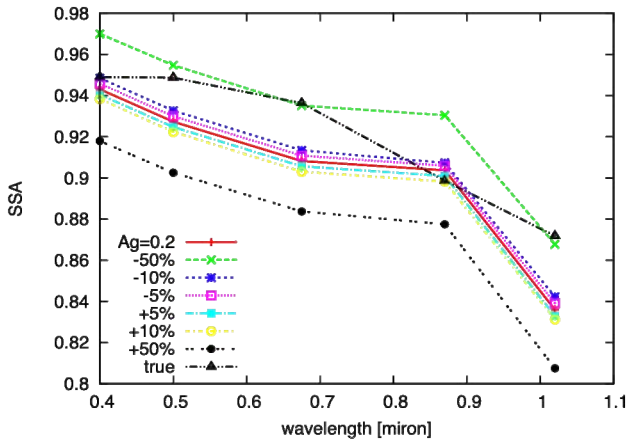

Fig. 1 SSA dependence on wavelengths ranging from 0.4 to 1.02 micron for various ground albedo (Ag) values

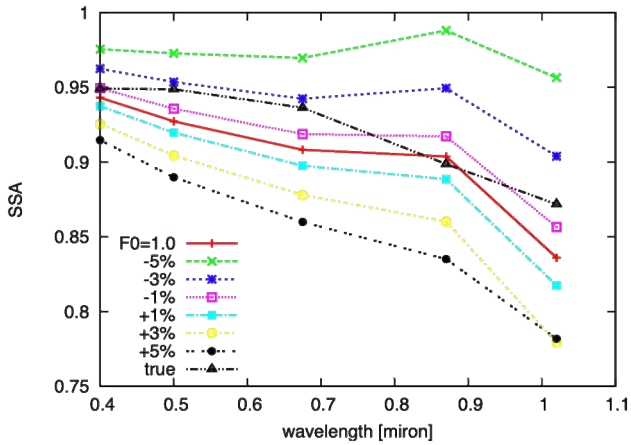

Fig. 2 Same as in Fig 1, but for various calibration constant (F0) values

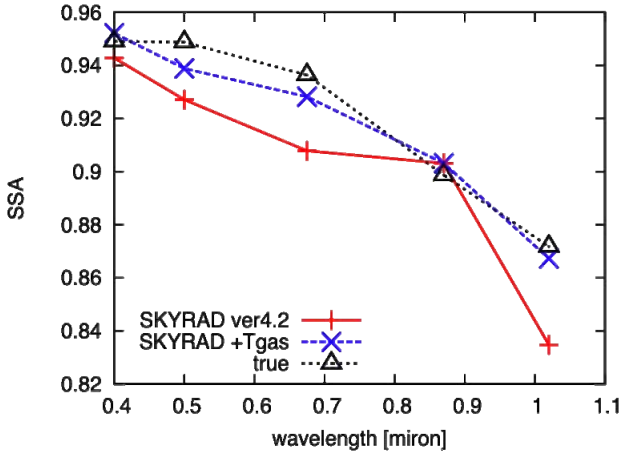

Fig. 3 Same as in Fig 1, but for gas absorption effects

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