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Development of quality control for the analysis in SKYNET and the estimation of the single scattering albedo

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It is important to accurately estimate the columnar aerosol optical properties in assessing the effect on the radiation budget associated with the aerosol direct radiative forcing. The SKYNET network is one of the ground-based aerosol monitoring networks for this purpose. In the SKYNET, the direct and diffuse solar irradiances are measured by using skyradiometer (Prede Co., Ltd, Tokyo, Japan), and the columnar aerosol optical properties (aerosol optical depth, single scattering albedo, real and imaginary part of refractive index and phase function, and size distribution) are retrieved by using its own inversion software called SKYRAD.pack version4.2 (Nakajima et al., 1996). However, it is pointed out that the value of single scattering albedo (SSA) from SKYNET is systematically larger than that from NASA AERONET (Holben et al., 1998), which is also well-known network similar to SKYNET. It is also found that SSA from SKYNET is sometime close to unity (Badarinath et al., 2011). To investigate the cause of above problems, we conducted sensitivity tests for the possible causes of error in SSA in the retrieval process of SKYRAD.pack. We also checked a difference in SSA between the inversion algorithms. From the sensitivity tests, it is found that error of -0.1 in surface albedo, -5% in solid view angle or -5% in the calibration constant result in errors of +3.0%, +2.3%, or +4.7% in SSA, respectively. As to the type of inversion method, this study used SKYRAD.pack version 4.2 with either the Phillips-Twomey method (Phillips, 1962; Twomey, 1963, standard method) or the maximum a posteriori (MAP) method (which is similar to the AERONET inversion algorithm). It is found from the simulation results that there are two cases of large deviation of the retrieved SSA from the true SSA value, i.e. 1) the MAP method underestimates the SSA value in the case of large coarse particle concentration in the size range larger than 10 μm in radius when a priori size distribution does not include the coarse particle mode as assumed in the SKYRAD.pack, and 2) the Phillips-Twomey method overestimates the SSA value when cirrus particles clouds exist in the atmosphere because this method regards the cirrus particle size distribution as a coarse aerosol size distribution. We also analyzed the real data at Pune (18.6˚N/73.8˚E) and Beijing sites (36.0˚N/140.1˚E) and compared the results with those of AERONET to study possible causes for the error in SSA. From the result, it is found that in cases of the cirrus contamination as detected by CALIPSO lidar, SSA of SKYNET Phillips-Twomey method is lager than that from the MAP and/or AERONET. And we found one significant dust case that Phillips-Twomey method seems to retrieved the size distribution of coarse dust particle mode more reasonably than that from MAP method with suppressed a priori coarse model size distribution. Therefore, we propose a new data screening method that rejects data in cases of 1) the aerosol optical depth at 0.5 μm is less than 0.4, 2) the reconstruction error of sun and sky irradiances is equal or larger than 7%, and 3) significantly large coarse mode size distribution. We applied above data screening to the data at Pune (April to December, 2008) and Beijing (February to September, 2004) and found that the SSA from SKYNET became close to that from AERONET.