



Aerosol impact on the brightening in Japan

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Surface solar radiation observed at numerous locations has decreased from the 1960s to the 1980s (Global dimming), thereafter increased (Global brightening). The dimming and brightening is considered to be due to the changes in both clouds and aerosols. Aerosols have a direct impact on the surface solar radiation by scattering and absorption. The impact is determined by three parameters: optical depth (AOD), single scattering albedo (SSA), and asymmetry factor, but the effect of asymmetry factor is rather smaller than the others. Therefore, the long-term changes in AOD and SSA are necessary to evaluate the aerosol impact on the global dimming and brightening. We have developed the method to estimate AOD and SSA from the hourly accumulated direct and diffuse irradiances measured by the ground-based broadband radiometers. In the estimation, the real part of the refractive index is fixed, and the size distribution is defined by the Junge distribution with a fixed shaping constant. Using the developed method, the measurements from 1975 to 2008 at 14 sites in Japan were analyzed. Consequently, a decrease of AOD by 0.02 and an increase of SSA by 0.21 during the period were seen. The surface solar radiation under the clear sky conditions, which was calculated from the estimated aerosol optical properties, was increased by 5% due to the changes in AOD and SSA; the influence of SSA was dominant. We also investigate the cloud impact on the surface solar radiation which was simply defined as the difference between the surface solar radiation under the cloudy sky conditions and under the clear sky conditions; the cloud impact had no statistically significant trends. The brightening in Japan may be due to the changes in aerosol optical properties, especially SSA. Our developed method is applicable to measurements compiled in the WRDC and BSRN and would be helpful to understand the long-term changes in AOD and SSA and their impact on the global dimming and brightening.