Analysis of factors causing variations in the absorption Ångström exponent of aerosols in Japan using skyradiometers

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Aerosols have brought the most significant uncertainty in predicting future climate change. To reduce the uncertainty, it is essential to better understand the optical properties of aerosols. Organic aerosols and mineral dust, which are the main aerosols, have been considered to cause only a weak light absorption, and their radiative forcing has been negative in most climate models. However, recent laboratory experiments and observations indicated that there should be aerosols (such as brown carbon) causing a strong light absorption in particular in the ultraviolet-to-visible wavelength regions. Although the Absorption Ångström exponent (AAE) was used as a useful index for representing the wavelength dependence of such light absorption, its observation has been limited. Under this circumstance, we made long-term observations using skyradiometers of SKYNET at 6 sites in Japan (Chiba, Fukue, Kasuga, Miyakojima, Sendai, and Takayama). Using our newly developed analysis algorithm package (SR-CEReS), we retrieved AAE values for the 6 sites to investigate factors causing their variations. While the theoretical AAE value of black carbon is considered to be unity, our analysis shows that the annual averages of AAE were in the range from 1.15 to 1.51, indicating the presence of aerosols having strong light absorption in the ultraviolet-to-visible wavelength regions at all the 6 sites. Moreover, urban sites tended to show higher AAE values. We additionally analyzed nitrogen dioxide and sulfur dioxide concentration data taken by the Multi-Axis Differential Optical Absorption Spectroscopy (MAX-DOAS) observations, which were conducted simultaneously with the skyradiometer. Then, it was suggested that the AAE could be enhanced by emissions from ships, factories, or steelworks.

Keywords: Aerosol, Skyradiometer, Absorption Ångström exponent (AAE)

