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# Continuous and multi-wavelength measurement of aerosol extinction coefficient by long-path propagation of LED light at Chiba, Japan

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It is well recognized that aerosols play a critical role in determining the Earth's radiation budget. Nevertheless, the accurate estimate of their direct and indirect radiative forcing is still challenging due to the complexity of their behavior in the ambient atmosphere. Ground-based remote sensing and optical observations have been conducted to characterize aerosol properties. A sunphotometer has widely been used for measuring the optical thickness of aerosols, but their data availability can be affected by clouds and time (usually daytime only). On the other hand, a visibility meter can provide visibility data and, consequently, aerosol extinction data even under cloudy conditions, whereas its operation is limited to a single wavelength (e.g., 875 nm). A nephelometer can provide aerosol scattering coefficients at multiple wavelengths, though the data often need corrections due to the relative humidity difference between the ambient and instrumental conditions. Under this circumstance, this study proposes a long-path measurement of aerosol extinction coefficients using a three-color, light-emitting diode (LED) light source emitting at 405, 455, and 505 nm. This approach realizes continuous and multi-wavelength observation (both day and night) of aerosol extinction coefficients near the ground surface level. A near-horizontal light path with a round-trip distance of around 600 m has been established inside the campus of Chiba University. A Newtonian telescope with a diameter of 130 mm collimates the LED light and directs it to a retro-reflector set up about 300 m away from the LED. The reflected light is condensed by a 130 mm diameter Newtonian telescope, and the light emitted from the eyepiece is introduced to the center of the optical fiber and detected by a UV-visible spectrometer. To remove background signals especially during the daytime, a square wave modulation to the LED light source is applied. Using this method, background signals are collected when the LED is off. These background signals are subtracted from the signals when the LED is on. With this instrument, test observations were performed from November 27 to December 5, 2020, together with a visibility meter (Vaisala, PWD52), a nephelometer (TSI3563), and a weather monitor. As expected, the raw signal was found to be directly proportional to the visibility but inversely proportional to the scattering coefficient and relative humidity. The extinction coefficient calculated from the visibility using the Koschmeider equation was compared with that derived from our instrument (at 505 nm). While the data from the visibility meter ranged up to 0.0006 km-1[LND1], our instrument indicated significant underestimation. However, their temporal variations were highly correlated (R = 0.88). This also implies that by using the long-path LED light, extinction coefficients for higher visibility (> 35 km) can be estimated.

Keywords: aerosol extinction coefficient, spectrometer, LED