Development of low-cost high-spectral-resolution lidar for air quality monitoring network

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[Abstract]

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A low-cost high-spectral-resolution lidar (HSRL) was developed for monitoring air quality. A multi-longitudinal mode laser, which was widely used for aerosol lidars and lower cost compared to single-mode lasers, was used as the light source of HSRL. The multimode laser was designed to have the same mode spacing as the free spectral range of interferometer optimized for the HSRL measurement. As a result, the laser had a short cavity length and large mode spacing, but it had a narrow spectral width comparable to single-mode lasers. The interferometer was scanned over the range of one fringe, and the interference visibility containing aerosol backscatter information was obtained at each height through fitting analysis of the scan data. The interference visibility and fringe position were calibrated with the reference signals taken from the part of the transmitted laser. We successfully carried out continuous measurement of aerosol profiles during the daytime and nighttime. The performance of the new system was greater than a previous version, which employed a laser with a much longer cavity. Vertical profiles of aerosol optical properties were retrieved from lidar signals every hour in near real-time. Aerosol extinction coefficients for four types of aerosol component (mineral dust, sea salt, black carbon, and air pollution aerosols) were then estimated from aerosol optical properties (extinction coefficient, extinction-to-backscatter ratio, backscatter color ratio, and depolarization ratio) measured by the lidar. Mass concentration of each aerosol component was converted from retrieved aerosol extinction coefficients. We successfully produced 1-month data set of aerosol concentrations from the continuous lidar measurement. In the future, the developed lidar can be used in the current lidar observation network of the Ministry of Environment of Japan to enhance monitoring of mass concentrations for various types of aerosol component.

[References]

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