Identification of Aerosol Types over Changchun Using AERONET and Low-Cost Sensor Data

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Abstract

Aerosols play an important role in the Earth's climate system by interacting with solar radiation and influencing atmospheric processes. Their properties and variability are especially relevant in urban regions, where natural and anthropogenic sources are combined. Understanding the distribution and characteristics of aerosols is therefore essential for improving our knowledge of atmospheric composition and its impact on climate and environmental conditions, particularly in rapidly developing and industrialized areas. In this study, we investigate aerosol types and variations in particulate matter ($PM_{2.5}$) concentrations in Changchun, a city in northeast China. The region is strongly influenced by industrial emissions, frequent dust storms, open waste burning, and biomass burning. To better characterize urban air quality, data from recently developed low-cost sensor networks are analyzed under a range of atmospheric conditions, including clear days, dust events, smoke episodes, and fireworks during holiday periods. $PM_{2.5}$ observations from the IQAir, PurpleAir, and AirGradient networks are used. More than ten sensors deployed across different parts of the city enable the evaluation of sensor performance and support the development of an improved city-wide monitoring system. In addition, data from the AERONET Changchun_JLU site, equipped with a sun-lunar-sky photometer, are used to analyze aerosol optical and microphysical properties and to identify aerosol types. Aerosol classification is first conducted using the conventional AOD-AE method, followed by a more advanced approach that combines AERONET-based clustering with a nearest-center matching algorithm based on single scattering albedo at 440 nm and the extinction Ångström exponent (440–870 nm). In summary, this integrated framework provides a comprehensive characterization of aerosol types and $PM_{2.5}$ pollution in Changchun. The results offer valuable insights for air quality monitoring and contribute to more effective pollution management strategies in complex urban environments.

Keywords

Aerosol Types, $PM_{2.5}$, AERONET, Low-cost Sensors, Aerosol Optical Properties