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Comprehensive characterization of organic aerosol in a traffic environment

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A substantial fraction of submicron particulate matter in urban areas consists of organic aerosol (OA). This study aimed to elucidate the chemical characteristics and sources of OA at a traffic location in Helsinki, Finland, using four datasets collected from 2018 to 2024. The measurement site was located at the curbside of Mäkelänkatu (Helsinki Supersite), maintained by the Helsinki Region Environmental Services (HSY). OA composition and mass size distribution were measured using a Soot Particle Aerosol Mass Spectrometer, while Positive Matrix Factorization was used to separate OA into different types.

The results showed that traffic predominantly produces two types of OA: hydrocarbon-like OA (HOA) and traffic-related oxygenated OA (Tr-OOA), each contributing 10–18% to the total OA. HOA, consisting mostly of hydrocarbon ions, peaked typically during the morning rush hour between 7 and 9 am. Tr-OOA peaked later in the morning, and was more oxygenated than HOA. Tr-OOA showed significant signals for $C_2H_4O_2^+$ (at m/z 60) and $C_3H_5O_2^+$ (at m/z 73), which are typically associated with biomass burning OA (BBOA). Additionally, Tr-OOA had a notable signal for $C_2H_5O_2^+$ (m/z 61), especially high during the winter 2022 campaign. Besides HOA and Tr-OOA, semi-volatile oxygenated OA (SV-OOA) also appeared somewhat related to traffic emissions, though its secondary nature suggested a stronger link to regional pollution than local traffic emissions.

The specific origin of Tr-OOA remained unclear. However, it could be somewhat atmospherically processed, as its concentration stayed elevated a few hours longer than HOA in the morning, and its mass size distribution peaked at a larger size than HOA. The hydrocarbon ratios in the mass spectra of Tr-OOA suggested a connection to modern vehicles with efficient exhaust after-treatment systems, which operate later in the morning than heavy-duty vehicles or diesel buses.

This study provides a comprehensive view of OA in an urban environment. The novel information on sources and size distributions will enhance the understanding of urban OA and support air quality authorities and decision-makers in finding effective measures to reduce the harmful effects of urban particulate matter.

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