Rapid physical and chemical transformation of traffic–related atmospheric particles near a highway

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ABSTRACT

The health of a substantial portion of urban populations is potentially being impacted by exposure to traffic–related atmospheric pollutants. To better understand the rapid physical and chemical transformation of these pollutants, the number size distributions of non–volatile traffic–related particles were investigated at different distances from a major highway. Particle volatility measurements were performed upwind and downwind of the highway using a fast mobility particle sizing spectrometer with a thermodenuder on a mobile laboratory. The number concentration of non–denuded ultrafine particles decreased exponentially with distance from the highway, whereas a more gradual gradient was observed for non–volatile particles. The non–volatile number concentration at 27 m was higher than that at 280 m by a factor of approximately 3, and the concentration at 280 m was still higher than that upwind of the highway. The proportion of non–volatile particles increased away from the highway, representing 36% of the total particle number at 27 m, 62% at 280 m, and 81% at the upwind site. A slight decrease in the geometric mean diameter of the non–volatile particle size distributions from approximately 35 nm to 30 nm was found between 27 m and 280 m, in contrast to the growth of non–denuded particles with increasing distance from the highway. Single particle analysis results show that the contribution of elemental carbon (EC)–rich particle types at 27 m was higher than the particle types at 280 m by a factor of approximately 2. The findings suggest that people living or spending time near major roadways could be exposed to elevated number concentrations of nucleation–mode volatile particles (<30 nm), Aitken–mode non–volatile particles (30–100 nm), and EC–rich fine–mode particles (>100 nm). The impact of the highway emissions on air quality was observable up to 300 m.

Keywords: Near–road, non–volatile particles, traffic–related air pollutant, spatial variation, single particle analysis