Short-term variation in near-highway air pollutant gradients on a winter morning

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Quantification of exposure to traffic-related air pollutants near highways is hampered by incomplete knowledge of the scales of temporal variation of pollutant gradients. The goal of this study was to characterize short-term temporal variation of vehicular pollutant gradients within 200–400 m of a major highway (>150 000 vehicles/d). Monitoring was done near Interstate 93 in Somerville (Massachusetts) from 06:00 to 11:00 on 16 January 2008 using a mobile monitoring platform equipped with instruments that measured ultrafine and fine particles (6–1000 nm, particle number concentration (PNC)); particle-phase (>30 nm) NO_3^-, SO_4^{2-}, and organic compounds; volatile organic compounds (VOCs); and CO_2, NO, NO_2, and O_3. We observed rapid changes in pollutant gradients due to variations in highway traffic flow rate, wind speed, and surface boundary layer height. Before sunrise and peak traffic flow rates, downwind concentrations of particles, CO_2, NO, and NO_2 were highest within 100–250 m of the highway. After sunrise pollutant levels declined sharply (e.g., PNC and NO were more than halved) and the gradients became less pronounced as wind speed increased and the surface boundary layer rose allowing mixing with cleaner air aloft. The levels of aromatic VOCs and NO_3^-, SO_4^{2-} and organic aerosols were generally low throughout the morning, and their spatial and temporal variations were less pronounced compared to PNC and NO. O_3 levels increased throughout the morning due to mixing with O_3-enriched air aloft and were generally lowest near the highway reflecting reaction with NO. There was little if any evolution in the size distribution of 6–225 nm particles with distance from the highway. These results suggest that to improve the accuracy of exposure estimates to near-highway pollutants, short-term (e.g., hourly) temporal variations in pollutant gradients must be measured to reflect changes in traffic patterns and local meteorology.

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