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Estimation of Particle Number and Mass Doses Inhaled in a Busy Street in Lublin, Poland

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Abstract : Transportation is considered to be responsible for increased exposure of road users – i.e., drivers, car passengers, and pedestrians as well as inhabitants of houses located near roads - to pollutants emitted from vehicles. Accurate estimates are, however, difficult as exposure depends on many factors such as traffic intensity or type of fuel as well as the topography and the built-up area around the individual routes. The season and weather conditions are also of importance. In the case of inhabitants of houses located near roads, their exposure depends on the distance from the road, window tightness and other factors that decrease pollutant infiltration. This work reports the variations of particle concentrations along a selected road in Lublin, Poland. Their impact on the exposure for road users as well as for inhabitants of houses located near the road is also presented. Mobile and fixed-site measurements were carried out in peak (around 8 a.m. and 4 p.m.) and off-peak (12 a.m., 4 a.m., and 12 p.m.) traffic times in all 4 seasons. Fixed-site measurements were performed in 12 measurement points along the route. The number and mass concentration of particles was determined with the use of P-Trak model 8525, OPS 3330, DustTrak DRX model 8533 (TSI Inc. USA) and Grimm Aerosol Spectrometer 1.109 with Nano Sizer 1.321 (Grimm Aerosol Germany). The obtained results indicated that the highest concentrations of traffic-related pollution were measured near 4-way traffic intersections during peak hours in the autumn and winter. The highest average number concentration of ultrafine particles (PN0.1), and mass concentration of fine particles (PM2.5) in fixed-site measurements were obtained in the autumn and amounted to $23.6 \pm 9.2 \times 10^3$ pt/cm^3 and 135.1 ± 11.3 µg/m^3, respectively. The highest average number concentration of submicrometer particles (PN1) was measured in the winter and amounted to $68 \pm 26.8 \times 10^3$ pt/cm^3. The estimated doses of particles deposited in the commuters' and pedestrians' lungs within an hour near 4-way TIs in peak hours in the summer amounted to $4.3 \pm 3.3 \times 10^9$ pt/h (PN0.1) and 2.9 ± 1.4 µg/h (PM2.5) and $3.9 \pm 1.1 \times 10^9$ pt/h (PN0.1) or 2.5 ± 0.4 µg/h (PM2.5), respectively. While estimating the doses inhaled by the inhabitants of premises located near the road one should take into account different fractional penetration of particles from outdoors to indoors. Such doses assessed for the autumn and winter are up to twice as high as the doses inhaled by commuters and pedestrians in the summer. In the winter traffic-related ultrafine particles account for over 70% of all ultrafine particles deposited in the pedestrians' lungs. The share of traffic-related PM10 particles was estimated at approximately 33.5%. Concluding, the results of the particle concentration measurements along a road in Lublin indicated that the concentration is mainly affected by the traffic intensity and weather conditions. Further detailed research should focus on how the season and the metrological conditions affect concentration levels of traffic-related pollutants and the exposure of commuters and pedestrians as well as the inhabitants of houses located near traffic routes.

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