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Aerosol and NO_x emission factors and submicron particle number size distributions in two road tunnels with different traffic regimes

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Abstract. Measurements of aerosol particle number size distributions (18–700 nm), mass concentrations (PM2.5 and PM10) and NO_x were performed in the Plabutsch tunnel, Austria, and in the Kingsway tunnel, United Kingdom. These two tunnels show different characteristics regarding the roadway gradient, the composition of the vehicle fleet and the traffic frequency. The submicron particle size distributions contained a soot mode in the diameter range D=80–100 nm and a nucleation mode in the range of D=20–40 nm. In the Kingsway tunnel with a significantly lower particle number and volume concentration level than in the Plabutsch tunnel, a clear diurnal variation of nucleation and soot mode particles correlated to the traffic density was observed. In the Plabutsch tunnel, soot mode particles also revealed a diurnal variation, whereas no substantial variation was found for the nucleation mode particles. During the night a higher number concentration of nucleation mode particles were measured than soot mode particles and vice versa during the day. In this tunnel with very high soot emissions during daytime due to the heavy-duty vehicle (HDV) share of 18% and another 40% of diesel driven light-duty vehicles (LDV) semivolatile species condense on the pre-existing soot surface area rather than forming new particles by homogeneous nucleation. With the low concentration of soot mode particles in the Kingsway tunnel, also the nucleation mode particles exhibit a diurnal variation. From the measured parameters real-world traffic emission factors were estimated for the whole vehicle fleet as well as differentiated into the two categories LDV and HDV. In the particle size range D=18–700 nm, each vehicle of the mixed fleet emits $(1.50\pm0.08)\times10^{14}$ particles km^{-1} (Plabutsch) and $(1.26\pm0.10)\times10^{14}$ particles km^{-1} (Kingsway), while particle volume emission factors of 0.209 ± 0.008 cm^3 km^{-1} and 0.036 ± 0.004 cm^3 km^{-1}, respectively, were obtained. PM1 emission factors of 104 ± 4 mg km^{-1} (Plabutsch) and 41 ± 4 mg km^{-1} (Kingsway) were calculated. Emission factors determined in this work were in good agreement with results from other studies.

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