Refinement of a model for evaluating the population exposure in an urban area

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Abstract

A mathematical model is presented for the determination of human exposure to ambient air pollution in an urban area; the model is a refined version of a previously developed mathematical model EXPAND (EXposure model for Particulate matter And Nitrogen oxiDes). The model combines predicted concentrations, information on people's activities and location of the population to evaluate the spatial and temporal variation of average exposure of the urban population to ambient air pollution in different microenvironments. The revisions of the modelling system containing the EXPAND model include improvements of the associated urban emission and dispersion modelling system, an improved treatment of the time-use of population, and better treatment for the infiltration coefficients from outdoor to indoor air. The revised model version can also be used for estimating intake fractions for various pollutants, source categories and population subgroups. We present numerical results on annual spatial concentration, time activity and population exposures to $PM_{2.5}$ in the Helsinki Metropolitan Area and Helsinki for 2008 and 2009, respectively. Approximately 60 % of the total exposure occurred at home, 17 % at work, 4 % in traffic and 19 % in other micro-environments in the Helsinki Metropolitan Area. The population exposure originating from the long range transported background concentrations was responsible for a major fraction, 86 %, of the total exposure in Helsinki. The largest local contributors were vehicular emissions (12 %) and shipping (2 %).