High-resolution mobile monitoring of traffic emissions in an urban area in Finland

L. Pirjola[1,2], T. Lähde[1], A. Malinen[1], J.V. Niemi[3], A. Kousa[3], T. Rönkkö[4], P. Karjalainen[4], J. Keskinen[4], A. Frey[5], and R. Hillamo[5]

[1]Department of Technology, Metropolia University of Applied Sciences, P.O. Box 4021, FI-00180 Helsinki, Finland
[2]Department of Physics, University of Helsinki, P.O. Box 64, FI-00014 Helsinki, Finland
[3]Helsinki Region Environmental Services Authority HSY, P.O. Box 100, FI-00066 HSY, Finland
[4]Aerosol Physics Laboratory, Tampere University of Technology, P.O. Box 527, FI-33101 Tampere, Finland
[5]Finnish Meteorological Institute, P.O. Box 503, FI-00101 Helsinki, Finland
Keywords: size distribution, black carbon, mobile laboratory, microenvironment.
Presenting author email: liisa.pirjola@metropolia.fi, liisa.pirjola@helsinki.fi

Traffic emissions significantly contribute to regional air pollution. Meteorology, traffic characteristics, road design and side structure affect near-road air quality by modifying dispersion of emissions (Hagler et al., 2010). Urban areas typically consist of street canyons where pollutant concentrations can be several times higher than in open areas due to reduced exchange of air and dispersion of pollutants inside the canyon. To obtain more detailed assessment of physical and chemical characteristics and source contributions of fine-particles in urban environment, an advanced measurement method was developed as part of the MMEA (Measurement, Monitoring and Environmental Assessment) program.

Three weeks street canyon campaign was performed in December 2010 in Helsinki. Mobile laboratory Sniffer (Pirjola et al., 2004) was driven on a 20 km route in the city center during the morning and afternoon rush hours, occasionally also at noon. The main street Mannerheimintie was driven back and forth always 5 times. Similarly, the measurements were carried out in side streets and background locations up to the shore. A special attention was given for the urban microenvironments close to the high traffic density street. Stationary measurements were conducted in four measurement stations by HSY, along the driving route.

The spatially and temporally high-resolution data included number concentration and size distribution of particles larger than 3 nm (ELPI, CPC and SMPS) as well as black carbon (Aethalometer) in PM_1 size fraction. Also continuously measured were NO, NO_2, NOx, CO, CO_2, PM_1, $PM_{2.5}$, meteorological and geographical parameters. A thermodenuder was used for volatility studies of particles.

Figure 1 shows the contour plot of the average total number concentration during the rush hours on 2 Dec, 2010. Temporal concentrations were highly variable. Meteorological conditions as well as traffic characteristics and urban planning was shown to have strong effect on the measured air quality.

Within a microenvironment where Mannerheimintie can be considered as an avenue canyon, the wake interference flow is produced (Vardoulakis et al., 2003). The windward concentrations of NO_x were around 26-59% of the leewind concentrations. Rather similar results (55%) were also predicted by a street canyon model OSPM (Berkowicz, 2000).

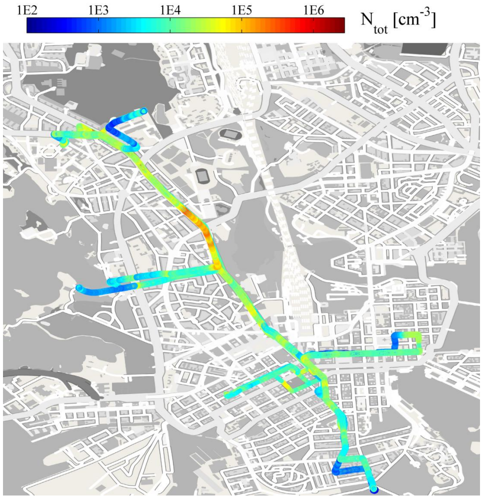

Figure 1. The map of downtown of Helsinki. The colour bar indicates the particle number concentration on Mannerheimintie and on the nearby streets.

More detailed analysis showed that the surrounding built environment combined to the predominant wind conditions changed the dispersion around the high traffic density streets markedly. The comparison of the stationary measurements to mobile measurements corresponded well promoting the mobile measurement method in an urban air quality studies.

MMEA is supported by Tekes (the Finnish Funding Agency for Technology and Innovation) and coordinated by the Finnish energy and environment cluster - CLEEN Ltd.

Berkowicz R. (2000). Environ, Monit. Ass. 65, 323-331.

Hagler G.S.W, Thoma E.D. and Valdauf R.W. (2010). *J. Air &Waste Manage. Assoc.* 60, 328-336.

Pirjola L., Parviainen H., Hussein T., Valli A., Hämeri K., Aalto P., Virtanen A., Keskinen J., Pakkanen T., Mäkelä T., Hillamo R (2004). *Atmos. Environ.* 38, 3625-3635.

Vardoulakis S., Fisher B.E.A., Pericleous K., and Gonzalez-Flesca N. (2003). *Atmos. Environ.* 37, 155-182.