Composition of and exposure to $PM_{2.5}$ while commuting in the metro and on the street

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Introduction

Contribution of traffic to personal $PM_{2.5}$ exposure is important for the assessment of PM health effects (1, 2, 3). We have recently started research activities aiming at improving our knowledge on the mass and number concentrations as well as size distributions and composition of fine particles in different traffic environments. So far we have conducted a short preliminary survey in different vehicles and a more comprehensive measurement campaign in the metro in Helsinki, Finland.

Methods

In this preliminary study in different vehicles we monitored the $PM_{2.5}$ mass concentrations (MIE personalData-RAM-1000) as well as particle number concentrations (P-TRAK Ultrafine Particle Counter Model 8525) while commuting in the city either by train, metro, bus or on foot.

In the Helsinki metro we collected $PM_{2.5}$ samples on teflon and quartz fibre filters at two underground and at one surface metro station. The $PM_{2.5}$ concentrations were also recorded continuously using a photometric method. Exposure to fine particles in commuting was measured inside a metro car using the same methods as at the stations. Samples were collected during three to five days from 6.30 am to 6.30 pm.They were analysed for their elemental (BC) and organic carbon (OC) content with thermal-optical transmission (TOT) method. The elemental composition was analyzed with ED-XRF.

Results

The mass and particle number concentrations showed large variability in different traffic environments and were in many occasions clearly higher than in urban background environment (Fig 1).

During the measurement campaign in the metro high concentrations of PM $_{2.5}$ were observed at the stations and also in the metro car, where the concentrations incre- ased whenever the car was in the tunnel and decreased when the metro car was on surface in open air (Fig 2).

The $PM_{2.5}$ samples collected in the metro contained very high concentrations of iron, and also e.g. manganese, copper, chromium and nickel concentrations were clearly elevated. The origin of these elements is probably the rails and wheels. At Station1 the effect of the tunnel construction work in the area were reflected in the concentrations of e.g. silicon, aluminum, and potassium (Table 1).

Conclusions

◆ Additional measurements in trains, trams, buses and personal cars are needed to obtain a more representative comprehension of the exposure to PM in traffic.

◆ The composition of $PM_{2.5}$ in the metro differs greatly from that of ambient PM. The size distribution of particles is likely to be different, too (2)

◆ We need more information about the mass and number concentrations as well as the size distributions of particles in the metro.

◆ Before making conclusions about the health effects of exposures to PM in metro we need more information about
- the relevance of short exposures to high concentrations for the health effects
- epidemiological and/or toxicological evaluation of the health risk of PM exposure in metro relative to the risks of PM exposure in street traffic and in ambient urban air.

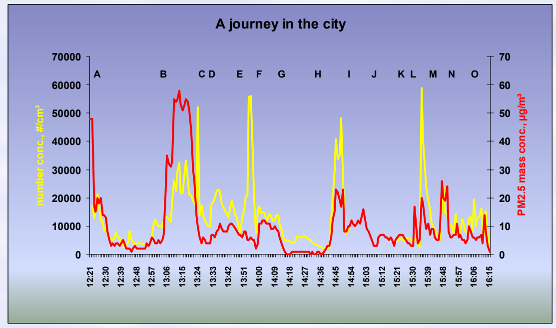

Figure 1. Particle mass ($PM_{2.5}$) and number (0.02 - > 1 µm) concentrations in different environments A: metro station, AB: commuting in a metro, BC: metro/railway station CD: street, DE: bus1, EF: street, FG: bus2, GH: cafe, HI: railway station, IJ: local train1, JK: station2, KL: train2, LM: train3, MN: railway station, NO: street.

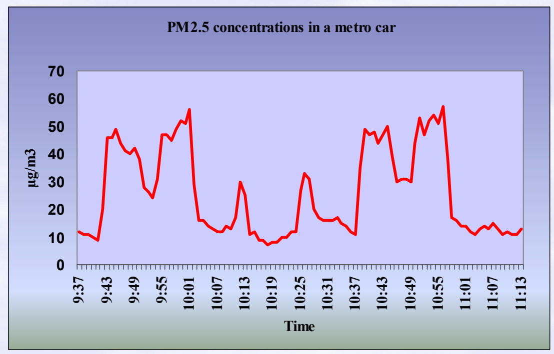

Figure 2. $PM_{2.5}$ concentrations (1 min values) inside a metro car while commuting

Table 1. The concentrations of some elements, $PM_{2.5}$ mass, BC, and OC in the metro (averages of 2 or 3 twelve hour samples collected between 6.30 am and 6.30 pm in March 2003) and at the urban traffic monitoring site (annual averages in 1997, BC and OC in 2002)

	Station1 undergr.	Station2 undergr.	Station3 surface	Metro car	Urban traffic 1997/2000
ng/m³					
Al	3100	300	90	200	59
Ca	810	210	82	99	71
Cl	190	270	96	110	43
Cr	42	88	2.0	13	
Cu	100	110	10	42	3.1
Fe	19000	36000	1300	6900	96
K	1600	150	65	140	85
Mn	220	420	16	81	3.3
Ni	19	35	2.7	10	2.0
S	400	440	210	500	830
Si	11000	690	280	660	
Ti	71	47	6.9	8.8	0.8
µg/m³					
PM2.5	84	58	8.5	18	12
BC		2.8			1.2
OC		6.6			3.0

References:

Adams, H., Nieuwenhuijsen, M., Colvile, R., McMullen, M., Khandelwal, P., 2001. Fine particle ($PM_{2.5}$) personal exposure levels in transport microenvironments, London, UK. The Science of the Total Environment 279 :29 - 44.

Johansson, C., Johansson, P-Å., 2003. Particulate matter in the uncerground of Stockholm. Atmospheric Environment 37: 3 – 9.

Chillrud, S., Epstein, D., Ross, J., Ramstrom, S., Spengler, J., Kinney, P., Elevated airborne exposures to manganese, chromium and iron from New York City´s subway system. Submitted.

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