Chemical composition of PM_1, $PM_{2.5-1}$ and $PM_{10-2.5}$ in an urban environment

J. Kozakova[1, 2], J. Schwarz[1], C. Leoni[2], M. Klan[2] and J. Hovorka[2]

[1] Laboratory of Aerosols Chemistry and Physics, Institute of Chemical Process Fundamentals of the ASCR, v. v. i., Prague, 165 02, Czech Republic

[2] Institute for Environmental Studies, Faculty of Science, Charles University in Prague, Prague, 128 01, Czech Republic

Keywords: intermodal fraction, $PM_{2.5-1}$, Sioutas cascade impactor, urban aerosol.

Presenting author email: kozakova@icpf.cas.cz

Coarse and fine particles overlap in aerodynamic particle size range 1 - 2.5 μm, known as the intermodal fraction ($PM_{2.5-1}$). Sources of both coarse and fine aerosols contribute to the intermodal fraction to a different extent relating to different meteorological conditions and types of locations. According to several studies, the intermodal fraction highly correlates with coarse aerosol in arid areas during high wind speed episodes (e.g. Kegler et al., 2001). In contrast, other studies have shown higher or comparable correlation with fine aerosol (Geller et al., 2004). The aim of this study was to determine the chemical composition of the intermodal fraction in urban and suburban sites and estimate the similarity with fine (PM_1) or coarse ($PM_{10-2.5}$) fraction.

24-hour concentrations of PM_1, $PM_{2.5-1}$ and $PM_{10-2.5}$ were sampled by a Sioutas personal cascade impactor sampler (PCIS) at an urban (Benatska) and a suburban (Suchdol) site in Prague, Czech Republic, during 15 days in summer 2014 and winter 2015. The ion composition (Ion chromatography) and the elemental composition (SEM + EDX) of collected samples were determined. In addition, basic meteorological parameters were monitored.

The highest median concentrations of PM_1 and $PM_{2.5-1}$ were observed during the winter season at both sites (Table 1).

Table 1. Median of 24-hour concentrations from PCIS.

Campaign	PM_1 (μg/m^3)	$PM_{2.5-1}$ (μg/m^3)	$PM_{10-2.5}$ (μg/m^3)
Benatska_s	8.5	0.9	1.4
Suchdol_s	8.5	0.9	1.8
Benatska_w	29.4	1.4	1.0
Suchdol_w	26.2	1.2	1.0

s-summer, w-winter

$PM_{2.5-1}$ strongly correlated (Spearman correl. coef.) with $PM_{10-2.5}$ during all campaigns (r_s=0.64-0.83) and an association with PM_1 was mostly weaker (r_s=0.26-0.78), apart from Suchdol winter measurement. In addition, during this Suchdol winter campaign $PM_{2.5-1}$ negatively correlated (r_s= -0.51) with wind speed (WS) probably due to closer relationship with PM_1. Conversely, for the Suchdol summer campaign positive correlation between $PM_{2.5-1}$ and WS (r_s=0.49) was found (closer relationship with $PM_{10-2.5}$).

High relative Ca^{2+} ion mass was analysed in $PM_{10-2.5}$ and $PM_{2.5-1}$, minimum relative Ca^{2+} ion mass was found in PM_1. Relative SO_4^{2-} ion mass in each fraction is shown in Figure 1.

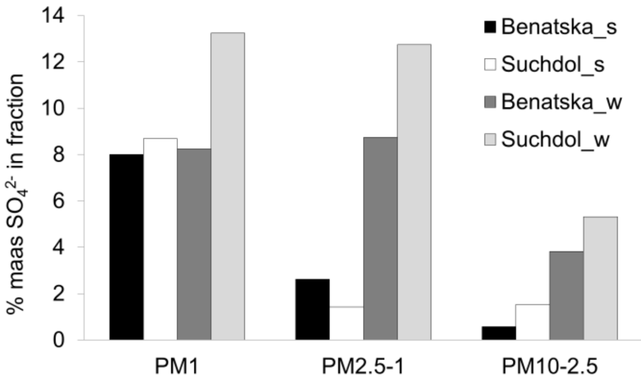

Figure 1. Relative SO_4^{2-} ion mass in all three fractions.

Higher relative mass of elemental sulphur was measured mainly in PM_1 and $PM_{2.5-1}$ during winter campaigns than in summer. Higher relative mass of elemental iron was determined in all three fractions in Benatska than in Suchdol, probably due to traffic in a close busy road. Conversely, in Suchdol higher relative mass of elemental sodium was measured for all fractions in both seasons. At Suchdol site seasonal differences were more evident. We observed higher relative mass of elemental iron and silicon and less sulphur in summer.

The behaviour of $PM_{2.5-1}$ depended on season, wind speed, relative humidity and location. $PM_{2.5-1}$ was strongly associated with $PM_{10-2.5}$ in all campaigns and the correlation with PM_1 was also high in some cases. Chemical composition of each fraction showed similarity between $PM_{2.5-1}$ and $PM_{10-2.5}$. Similarity between $PM_{2.5-1}$ and PM_1 was found mainly in some winter days.

The project is supported by Charles University Grant Agency (274213) and the Czech Grant Agency (P503/12/G147).

Geller, G.D., Fine, P.M. and Sioutas, C. (2004) *The Relationship between real-time and time-integrated coarse (2.5–10 μm), intermodal (1–2.5 μm), and fine (<2.5 μm) particulate matter in the Los Angeles basin*, J. Air Waste Manag. Assoc., 54, 1029-1039

Kegler, S.R., Wilson, W. E. and Marcus, A.H. (2001) *PM 1, intermodal ($PM_{2.5-1}$) mass, and the soil component of PM 2.5 in Phoenix, AZ, 1995-1996*, Aerosol Sci. Technol., 35, 914-920