The effect of size, location, occupancy and microclimatic factors on air quality of university lecture rooms

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As has been repeatedly documented in scientific literature, one of the most polluted indoor microenvironment can be found at schools. School buildings and classrooms suffer from poor air quality from two reasons: (1) Schools in cities are frequently situated in quarters or near streets with dense traffic and the infiltration of freeway particles into the school buildings represents an important source of pollutants (Janssen et al. 2001; Green et al. 2004) and (2) High levels of particulate matter in schools are frequently attributed to human activity and insufficient frequency of cleaning which is not capable in removing deposited particles (Branis et al., 2005; Fromme et al., 2007). Since these particles are only partly removed, they can be resuspended again and again. To ascertain the effect of infiltration and resuspension under various conditions (such as position of the classroom with respect to outdoor sources, its size and occupancy) we performed a year long project in three university lecture rooms situated in the centre of Prague.

Twenty-four hour mass concentrations of size-segregated aerosol were measured simultaneously in three university lecture rooms and outdoors in the central part of Prague (Czech Republic) by a five-stage A - F (<0.25µm, 0.25-0.5µm, 0.5-1.0µm, 1.0-2.5µm and 2.5-10µm) Personal Cascade Impactor Sampler (PCIS). Identical sets of instruments were deployed at the outdoor and indoor sites. Other variables such as CO_2, ventilation, temperature, relative humidity, occupancy were monitored as well. The measurements were performed during all seasons of the year during 11 three to four-day long campaigns involving working days as well as weekends and holidays.

The results documented that finer indoor size fractions (below 500nm) were significantly affected by outdoor concentrations while coarse particulate matter levels ($PM_{2.5-10}$) were predominantly dependent on the number of students in the lecture rooms. Nevertheless, some effect of human presence on the PM below 500nm was recorded as well, indicating a possible effect of the so called personal cloud (Table 1; Figure 1). The level of particulate matter concentrations corresponded to the proximity to the adjacent street (the closer the lecture room the higher the average PM concentration) and to the size of the size of the lecture room (the smallest was the space the highest PM concentrations were recorded).

In addition, concentrations of carbon dioxide frequently reached values over 1500ppm and higher. One of the common problems in all the three lecture rooms was very low relative humidity (around 30-35%). The results of the study not only confirmed previous results but also showed that measurements in one classroom per school may be insufficient because differences in position, size and occupancy may affect the concentrations of aerosol from which the estimates of exposure are made for the whole population of students in a particular school.

Table 1. The effect of occupancy on size resolved aerosol. OC - occupied; UOC - unoccupied periods; A, B, C, D, F - impactor stages; CPM ($PM_{10-1.0}$). B11, B12, B14 - lecture rooms.

	B11		B12		B14	
	OC	**UOC**	**OC**	**UOC**	**OC**	**UOC**
A	2.18	0.78	2.56	0.49	2.88	0.50
B	1.50	0.66	1.32	0.56	1.45	0.78
C	1.14	1.01	1.01	0.61	1.07	0.88
D	4.64	4.03	5.13	3.50	4.24	4.49
F	10.15	10.02	10.06	6.22	9.96	7.79
PM_{10}	18.30	15.78	20.08	11.38	20.03	11.77
CPM	3.68	1.44	3.88	1.05	4.33	1.29

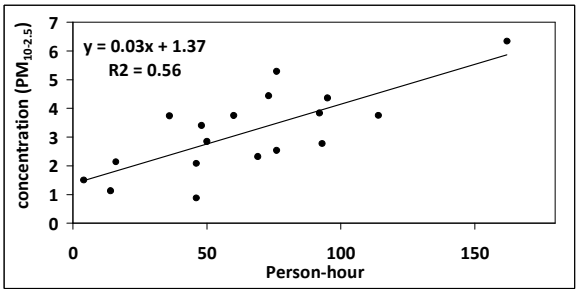

Figure 1. The relationship between coarse PM ($PM_{10-2.5}$) and occupancy (in person-hours) in one lecture room.

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