Spatial variation of particle number concentration in school microscale environment

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1 Introduction

There is significant toxicological evidence of the effects of ultrafine particles (<100nm) on human health (WHO 2005). Studies show that the number concentration of particles has been associated with adverse human health effects (Englert 2004).

This work is part of a major study called 'Ultrafine Particles form Traffic Emissions and Children's Health' (UPTECH), which seeks to determine the effect of the exposure to traffic related ultrafine particles on children's health in schools (http://www.ilaqh.qut.edu.au/Misc/UPTECH%20Home.htm).

Quantification of spatial variation of particle number concentration (PNC) in a microscale environment and identification of the main affecting parameters and their contribution levels are the main aims of this analysis.

2 Materials/Methods

25 state primary schools were randomly selected within the Brisbane metropolitan area. In each school three outdoor sites (A, B and C) were selected across the school ground to cover the whole school area. An analysis of data from the first ten schools is presented in this paper.

At each site, PNC was measured using a TSI® 3781 Condensation Particle Counter (CPC). Meteorological and other air quality parameters were also measured at a central site (B). In addition, an automatic traffic counter was installed on the busiest road adjacent to the school, in order to measure traffic intensity.

High correlation between sites can be an indicator of the spatial uniformity (Sarnat et al. 2010). However, they might still have significant absolute concentration differences (Wilson et al. 2005). The Intersite Spearman correlation coefficient was calculated at each school and the coefficient of variation (CV) was chosen to provide additional information about spatial variation between the sites. However, there is a level of uncertainty associated with the measurements which should be taken into account for spatial variation analysis.

Three CPCs were set up side by side for three days in order to assess their measurement uncertainty. A CV = 0.25 was found to be the spatial variation significance level.

A partial correlation coefficient (PCC) between CV and wind direction, wind speed and traffic intensity was also calculated to assess the effects of each parameter on spatial variation, while the rest of the parameters remained constant. Data processing and statistical analysis were conducted using Excel, Igor Pro and R.

3 Results and Discussion

Figure 1 illustrates the 10th, 25th, 50th, 75th and 90th percentile of the CVs at the first ten schools during weekdays. The level of significance for the CV is shown by the horizontal dashed line. Only four schools (S02, S07, S09 and S10) had a significant median CV value.

The PCC considers the correlation between each pair of variables while holding the value of each of the other variables constant (Zar 1999). Spearman's PCC was used in order to assess the relationship between some measured parameters and their likely affect on CV.

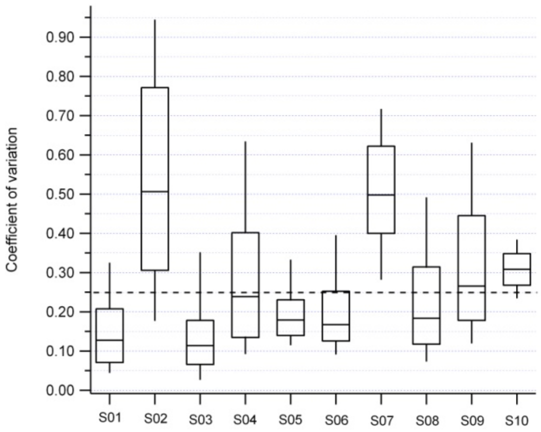

Figure 1: Coefficient of variation between three sites for ten schools during weekdays

Spearman's PCC was calculated between CV and wind direction, wind speed and traffic intensity (see Table 1). Wind direction was coded as 1 and 0, which indicates a direction from the main road towards the school, and from the school towards the main road, respectively.

Table 1. Partial correlation coefficient between CV and wind speed, wind direction and traffic intensity.

School	01	02	03	04	05	06	07	08	09	10
Traffic	.38	NS	NS	.54	.25	.37	.45	.44	.34	.26
Wind speed	NS	NS	NS	NS	NS	NS	-.19	NS	NS	NS
Wind direction	.32	NS	NS	.35	-.25	NS	NS	.3	NS	NS

NS: Not significant

Traffic and wind direction were positively correlated with CV, with the exception of S05 for wind direction. This shows that spatial variation increases as traffic intensity increases or when the wind direction is from the main road towards the school. Wind speed was found to be negatively correlated with spatial variation in one school and no significant correlation was found for the rest of the schools.

The correlation values show that traffic intensity had the highest impact on spatial variation. All schools with significant spatial variation were close to a road with a median traffic intensity higher than 800 vehicles/hour, however the traffic intensities for main roads adjacent to all other schools were lower.

4 Conclusions

CV was used to quantify spatial variation in the microscale school environment. Aerosol PNC spatial variation was found to be positively correlated with traffic intensity and PNC was found to increase when the wind direction was from the main road. Local traffic intensity was determined to be the main parameter affecting spatial variation, with a median traffic intensity of higher than 800 vehicles/ hour found to cause significant spatial variation across the microscale school environment.

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