# Preliminary results on the chemical composition of outdoor airborne particles at urban schools and possible implications for the air quality in classrooms

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## 1 Introduction

Vehicle emissions are a significant source of fine particles ($D_p$ < 2.5 µm) in an urban environment. These fine particles have been shown to have detrimental health effects, with children thought to be more susceptible. Vehicle emissions are mainly carbonaceous in nature, and carbonaceous aerosols can be defined as either elemental carbon (EC) or organic carbon (OC). EC is a soot-like material emitted from primary sources while OC fraction is a complex mixture of hundreds of organic compounds from either primary or secondary sources (Cao et al., 2006). Therefore the ratio of OC/EC can aid in the identification of source. The purpose of this paper is to use the concentration of OC and EC in fine particles to determine the levels of vehicle emissions in schools. It is expected that this will improve the understanding of the potential exposure of children in a school environment to vehicle emissions.

## 2 Materials/Methods

Airborne Particulate Matter with aerodynamic diameters equal to or less than 2.5 micrometer ($PM_{2.5}$) was collected in 17 Schools (S01-S17). The seventeen schools selected for this study are in different suburbs in the city of Brisbane, Australia. The schools that were chosen were not near any other significant source of air pollution other than road traffic. At each school a site that was close to the middle of the school that provided the best overall exposure was chosen. The sampling campaign at each school took place from Monday to Friday, to give a total of 5 samples per school. $PM_{2.5}$ was collected during school hours (8am to 5pm) on a preloaded 37 mm quartz cassette filter (SKC) for OC and EC analysis. After sampling, the filters were placed in a ziplock bag and frozen. OC and EC were analysed at Chester Labnet according to the IMPROVE protocol on a thermal/optical transmittance carbon analyser. This chemical sampling was a part of a larger campaign to study the effect of Ultrafine Particle from Traffic Emissions on Children's Health, subsequently abbreviated as UPTECH (www.ilaqh.qut.edu.au/Misc/UPTECH%20Home.htm).

## 3 Results and Discussion

The OC, EC and OC/EC ratio at selected schools is given in Table 1. The average OC/EC ratio at each school ranged from 2.72 to 13.6, with an average ratio of 6.7. The average OC/EC ratio at each school was above 2, which indicated that secondary organic aerosols (SOA) were present (Chow et al., 1996). Since the OC/EC ratio varied widely, the levels of SOA varied from school to school.

Table 1: Average OC and EC results at selected schools

| School ID | OC (µg m$^{-3}$) | EC (µg m$^{-3}$) | OC/EC ratio |
|---|---|---|---|
| S01 | 2.76 ± 0.34 | 0.23 ± 0.19 | 13.6 |
| S07 | 2.96 ± 0.35 | 1.28 ± 0.24 | 2.72 |
| S12 | 1.93±0.26 | 0.42±0.16 | 4.58 |
| S15 | 3.01 ± 0.35 | 0.39 ±0.15 | 7.96 |

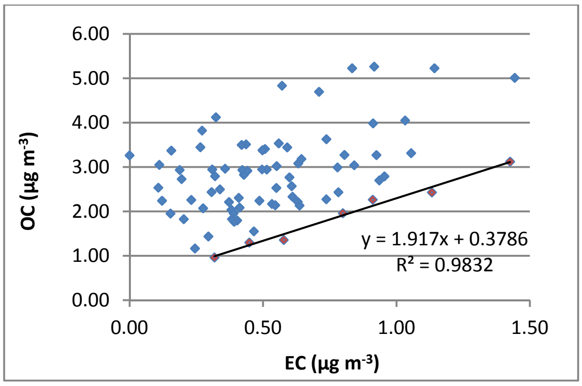
In order to determine the contribution of secondary organic carbon (SOC) and hence the primary organic carbon (POC), the minimum OC/EC ratio ($OC/EC_{min}$) was determined (Figure 1). This ratio represents a stable mixture of EC with POC and therefore points above the $OC/EC_{min}$ line are taken to contain added OC, or

SOC (Harrison and Yin, 2008). The $OC/EC_{min}$ was determined to be

$$OC = 1.92EC + 0.379$$

which provides an estimation of the concentration of POC. The intercept value is due to the contribution of non-combustion related OC to the $OC/EC_{min}$ such as paved road dust (Keywood et al., 2011).

Figure 1: Relationship of OC to EC for samples collected at all 17 schools.




The $OC/EC_{min}$ calculated is similar to the ratio calculated by Keywood et al (2011) in Melbourne, Australia. The calculated minimum ratio of 1.92 is closer to the expected ratio for gasoline vehicles rather than diesel vehicles (Ancelet et al., 2011).
Based on the selection criteria for the schools, the only expected source of POC at the schools are vehicle emissions, therefore an estimation of the contribution from vehicle emissions to the total carbon ($TC_{veh}$) concentration was obtained with the following equation:

$$TC_{veh} = EC + (POC – 0.379)$$

The concentration of $TC_{veh}$ at the schools ranged from 0.68 to 2.9 with an average of 1.6 µg $m^{-3}$. The concentration of SOC at each school was also calculated and gave an average of 1.4 µg $m^{-3}$. The levels of vehicle emissions varied from school to school in accordance with the traffic and wind conditions. In general, schools with the highest traffic counts had the highest $TC_{veh}$ levels. The direction of wind in relation to the roads bordering the schools was also a significant factor in levels of vehicle emissions at the schools.

## 4 Conclusions

The $OC/EC_{min}$ was established for all schools which enabled the levels of SOC at each school to be determined. Based on the results, the concentration of carbonaceous aerosols from vehicles at each school was estimated and the average was 1.6 µg $m^{-3}$. The levels of vehicle emissions were found to vary at each school depending on the traffic and meteorological conditions and these could have potential implications when considering the indoor air quality in the classrooms.

Table 2: Estimated average concentration of POC, SOC and $TC_{veh}$ at selected schools

| School ID | POC (µg $m^{-3}$) | SOC (µg $m^{-3}$) | $TC_{veh}$ (µg/ $m^{-3}$) |
|---|---|---|---|
| S01 | 0.83 | 1.9 | 0.68 |
| S07 | 2.3 | 0.38 | 2.9 |
| S12 | 1.2 | 0.75 | 1.2 |
| S15 | 1.1 | 1.9 | 1.1 |

## 5 References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