Characterisation of ambient fine and ultrafine aerosol particulate matter in Suva, Fiji

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Combustion emissions are a source of fine ($PM_{2.5}$ < 2.5 µm) and ultrafine (UFP < 0.1 µm) aerosol particulate matter (PM). UFPs have large surface area per unit mass and are comparable in size to the cellular structure of the lungs; making them potentially harmful to human health; particularly when composed of black carbon (Donaldson *et al.* 2001). In Suva, the capital of Fiji, concentrations of black carbon in $PM_{2.5}$ are 2.9 ± 0.1 $\mu g.m^{-3}$; indicating that combustion activities are major contributors to Suva's PM. This work characterises ambient aerosol PM in Suva, focusing on UFPs and $PM_{2.5}$.

Suva is located on a peninsula, in the southeast of Viti Levu, the largest of the Fiji Islands. Prevailing winds are from the east-southeast. The monitoring site is located at approx. 18 m height in Suva city centre, on the west side of the peninsula; near to the Suva bus terminal, city markets, an industrial area and a shipping port.

At the city site, $PM_{2.5}$ concentration, wind speed and wind direction were recorded using a Turnkey Osiris sampler. In addition, ultrafine particle number concentration (PN) and average diameter (dp) were measured using a Philips Aerasense Nanotracer; over a 7 day period.

Lowest hourly mean (Figure 1), averaged over seven days, for PN was $1.07\times 10^4 \pm 9\times10^2$ cm^{-3} and $PM_{2.5}$ was 5.6 ± 0.7 $\mu g.m^{-3}$; both occurring at 14:00. Peak hourly mean occurred at 19:00 for PN ($2.33\times10^4 \pm 7\times10^2$ cm^{-3}) and 21:00 for $PM_{2.5}$ (16.6 ± 1.2 $\mu g.m^{-3}$). This pattern of lowest PM concentration in the middle of the day largely reflects the more favourable dispersion conditions at this time. Waste burning activities, throughout the evening, influence this diurnal cycle; displaying a similar daily PN pattern to cities with evening contributions from household heating (Borsos *et al.* 2012). Mean UFP diameter (dp) was 39 ± 0.6 nm;

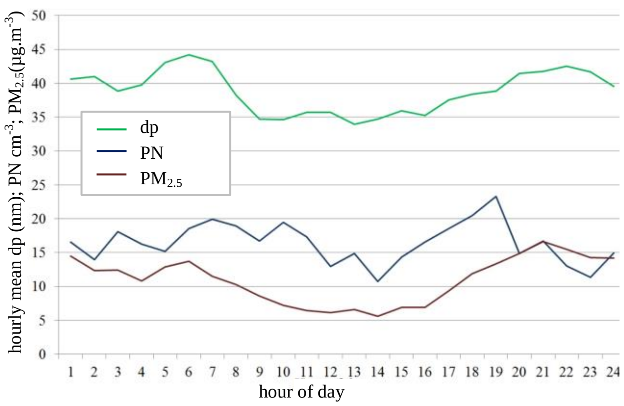

Figure 1: Daily variation of $PM_{2.5}$, PN and dp; Suva city

there is a significant positive relationship between $PM_{2.5}$ concentration and dp, $r(22)=0.86$, $p<0.001$.

Maximum one-minute readings for $PM_{2.5}$ were 66.8 $\mu g.m^{-3}$ (mean 11.2 ± 0.2 $\mu g.m^{-3}$); with 16-second PN readings peaking at 3.71×10^5 cm^{-3}. Mean PN for Suva city, $1.64\times10^4 \pm 6\times10^2$ cm^{-3}, is similar to that of several European cities that have larger populations than Suva (Aalto *et al.* 2005, Borsos *et al*. 2012, Mazaheri *et al.* 2014)).

Mobile sampling of ultrafine particle concentration exposure was also conducted for various environments throughout Suva (Figure 2). Highest concentrations were recorded whilst travelling on buses ($2.25\times10^5 \pm 3.0\times10^4$ cm^{-3}), in taxis ($7.39\times10^4 \pm 8.3\times10^3$ cm^{-3}) and when walking ($3.49\times10^4 \pm 2.9\times10^3$ cm^{-3}). These indicate that transport emissions contribute substantially to UFP exposure in Suva. Exposure whilst travelling is of significant interest, as a survey of Suva residents in 2015 indicated that more than 70 % of Suva residents travel by bus to work, spending around 30 minutes per day on a bus.

Understanding UFP characteristics in Suva will assist in formulating effective air emissions control strategies, with the potential to reduce population exposure.

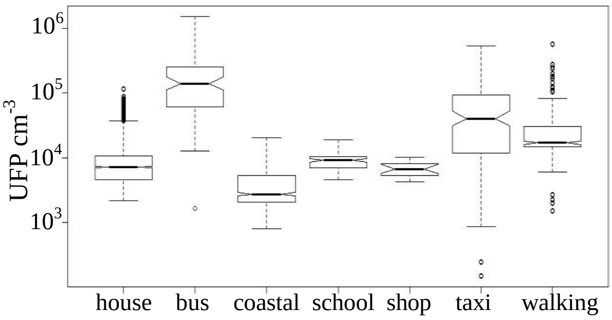

Figure 2: UFP number concentration for selected Suva environments

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