Contribution of school location and travel-to-school on schoolchildrens’ exposure to ultrafine particles at four schools with contrasting traffic influence

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Ultrafine Particles from Traffic Emissions and Children's Health (UPTECH)
NZ Pilot study aims

1. Is exposure at high-traffic schools systematically higher than low-traffic schools
2. How significant is exposure at schools relative to travel-to-school exposure?
3. Does school location influence exposure at school or during travel to/from school?
Measurement overview

• Min 10-day campaigns at each school

<table>
<thead>
<tr>
<th>School</th>
<th>Sampling campaign</th>
</tr>
</thead>
<tbody>
<tr>
<td>SubLowT</td>
<td>Apr 2011</td>
</tr>
<tr>
<td>SubHighT</td>
<td>Jun 2011</td>
</tr>
<tr>
<td>CentHighT</td>
<td>Apr 2012</td>
</tr>
<tr>
<td>CentLowT</td>
<td>Sep 2012</td>
</tr>
</tbody>
</table>
School grounds measurements

- PNC (2 sites at SubHighT) (TSI 3781, SMPS, 3007)
- PM$_{10}$ (TSI AM510)
- CO$_2$ (TSI Q-Trak)
- CO (Langan T15)
- (NO$_2$ diffusion tubes at SubHighT)
Classroom measurements

- Do outdoor pollutants penetrate indoors?
- Are there pollution sources indoors?
- PNC (TSI 3007)
- PM$_{10}$
- CO$_2$, CO
- BC (one school)
Travel to/from school

- PNC (TSI 3007)
- CO, CO$_2$, PM, BC, GPS, images
- Mostly walking
Mean school-hours concentrations

- All data adjusted to $N_{(Dp > 10 \text{ nm})}$
- Local traffic dominant over suburban/central location
- For suburban schools $N_{\text{ext}}$ 60% higher at high-traffic site
- For high-traffic schools $N_{\text{ext}}$ 50% higher for central site
- Range of mean I/O ratios from 0.4 – 1.7
SubHighT- Moderate SW winds

SubLowT

SubHighT

PNC / cm$^3$

0 5000 10000 15000 20000 25000 30000 35000 40000

00:00 04:48 09:36 14:24 19:12 00:00

playground
classroom

playground
classroom

near-road

NIWA
Taihoru Nukurangi
SubHighT- Moderate NE winds

SubLowT

SubHighT

SubHighT

NE wind

Note change of scale

NIWA
Taihora Nukurangi
## Mean particle number concentrations (Suburban)

<table>
<thead>
<tr>
<th>Location</th>
<th>SubLowT</th>
<th>SubHighT</th>
<th>SubHighT westerlies</th>
<th>SubHighT easterlies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Playground (24 hrs)</td>
<td>7 300</td>
<td>14 000</td>
<td>9 000</td>
<td>16 000</td>
</tr>
<tr>
<td>Playground (School hours only)</td>
<td>8 600</td>
<td>14 000</td>
<td>6 000</td>
<td>22 000</td>
</tr>
<tr>
<td>Near-road (school hours only)</td>
<td>n/a</td>
<td>23 000</td>
<td>11 100</td>
<td>40 600</td>
</tr>
</tbody>
</table>

- HighT ~ 2 x LowT
- Near-road ~ 2 x playground
- Easterlies ~ 2 – 4 x westerlies
I/O ratios

- No evidence of significant indoor sources in ¾ schools
- Most modern school appeared most sealed and exhibited indoor sources, possibly associated with lunchtime
Mean school-hours exposures

- Exposures during travel substantially elevated for central schools only
- Short journey durations (mean 32 mins) means travel makes minor contribution to school-day mean exposure
For Central schools doses during ~30 min commutes are comparable to ~4 hrs in school.

Low sensitivity to alternative breathing rate estimates.
Contribution of travel to mean # particles inhaled during school hours

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<th>CentLowT</th>
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<tbody>
<tr>
<td>Contribution as % of total inhaled dose</td>
<td>6%</td>
<td>5%</td>
<td>30%</td>
<td>25%</td>
</tr>
</tbody>
</table>
School travel routing

- Sampling routes selected from representative subset of modelled trips based on travel survey
- No travel on motorways
CentLowT: Mobile PNC
PNC ratio mobile:reference
PNC ratio mobile:reference

Traffic:

High  Low  High  Low  High  Low

route

mobile:reference
“high” traffic routes
“low” traffic routes
Influences, biases and limitations

• Most Auckland primary schools have very localised catchment areas (some are zoned)
• Suburban schools had shorter commutes on less-trafficked roads
• Concentrations at high-traffic sites were sensitive to wind direction
• At studied LowT schools 38 – 43 % of children walk to school
• No specific data for HighT schools, but no relationship found between %walk and local traffic amongst other schools
Conclusions

- **Adjacent motorway** major determinant of at-school exposure
- **Centrality** major determinant of travel (walking) exposure
- Exposures during travel to school ~ 2 x exposures at school for Central schools
- ¾ schools had no identifiable indoor sources, but I/O ranged from 0.4 – 1.7
- Temporal variation in outdoor PNC controlled mainly by meteorological factors
- Strong PNC gradient (factor of 2) within 50 m of motorway boundary
- Net effect of travel was minor for suburban schools due to low traffic levels *en route* and short journeys.
- Net effect of travel was substantial for central schools due to higher traffic levels *en route* and longer journeys.
- Confirmed strong traffic-related exposure gradient between schools
Conclusions

- Ratio of travel to reference (UB) concentrations:
  - Median = 2.2, mean: 3.6, range: 2.0 – 5.2
  - insensitive to wind speed
  - 70% higher on high traffic routes
  - Higher ratio observed on ‘downwind’ side of major road
  - Influence of street topography possible, but difficult to analyse

- Mobile exposure appears related to time spent in close proximity to traffic, including waiting at crossings

- Variation between and within routes implies options to reduce exposure through route choice and infrastructure design

- Further analysis ongoing
Thanks for your attention

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