Characterisation of urban aerosol

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Characterisation of urban aerosol

Size (number) distribution

Size (mass) distribution
Characterisation of urban aerosol

Particle Number Concentration 1/cm³

Particle Diameter (nm)

- Sulfuric Acid
- Organic
- Nitrate
- Sea Salt
- Mineral
- Carbonaceous

$10^1$ $10^2$ $10^3$ $10^4$
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Manchester in winter..

[Graph showing aerosol particle diameters and their composition over time]

- Sulfate
- Sea Salt
- Mineral
- Sulfuric Acid
- Organic
- Nitrate
- Carbonaceous
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Manchester

Edinburgh

Manchester in winter

Edinburgh

SASUA3 - Edinburgh

Winter

Organics
Sulphate
Nitrate

dM dlogDa (μgm⁻³)
Characterisation of urban aerosol

Vancouver

Pacific2001: Langley Site

Urban

dM dlogDa (µg m⁻³)

Pacific2001: Slocan Park

Semi Rural

Pacific2001: Sumas Site

Rural

NIWA
Taihoronukurangi
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![Graph showing the relationship between NOx (ppb) and \(<200\text{nm}\) particulate organics.]
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Figure 4. Average aerosol size distributions for the main $k$-means cluster category: Traffic, Nucleation and Urban Background. Only the main cities BCN, MAD and BNE were considered.

Table 4. $k$-means cluster categories average size distribution size mode peaks and corresponding area percentage. Only the main cities BCN, MAD and BNE were considered. Note the two Aitken modes for Urban Background.

<table>
<thead>
<tr>
<th>Category</th>
<th>Nucleation</th>
<th>Aitken</th>
<th>Accumulation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traffic</td>
<td>–</td>
<td>$31 \pm 1 \text{ nm}$ (86%)</td>
<td>$120 \pm 2 \text{ nm}$ (14%)</td>
</tr>
<tr>
<td>Nucleation</td>
<td>$17 \pm 1 \text{ nm}$ (43%)</td>
<td>$53 \pm 7 \text{ nm}$ (57%)</td>
<td>–</td>
</tr>
<tr>
<td>Urban Background</td>
<td>–</td>
<td>$38 \pm 3 \text{ nm}$ (71%), $72 \pm 2 \text{ nm}$ (25%)</td>
<td>$168 \pm 14 \text{ nm}$ (4%)</td>
</tr>
</tbody>
</table>

Brines et al., 2015
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Figure 5. Mean SMPS size distributions on a nucleation day at each selected city, NO$_x$ average concentration and the frequency of occurrence of the Nucleation cluster for: (a) Barcelona, (b) Madrid, (c) Brisbane, (d) Rome and (e) Los Angeles. Please note that NO$_x$ concentrations for Madrid represent NO$_x$/2 and for Los Angeles NO$_x$/10. These values are 30–65% lower on nucleation days than the corresponding sampling period average levels.
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How does the diurnal pattern relate to other pollutant measurements, meteorology and size distribution?
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- bimodal size distribution, as typically found in vehicle exhausts, with a dominant peak at 20–40 nm (traffic-related nucleated particles) and another at 70–130 nm (soot particles).
- diurnal pattern correlates with traffic rush hours
- Correlated with very high levels of traffic pollutants, such as NO, NO2, BC and CO
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- Bimodal size distribution, with a low peak in the nucleation mode at 10–20 nm and a main peak at 50–90 nm.
- It occurs throughout the day, with a peak during daytime, and it is associated with the lowest pollution levels of all the Traffic clusters.
- The shift to smaller sizes of the 20–40 nm peak of T1 and T2 towards the nucleation mode in T3 might indicate particle evaporation in Barcelona, Madrid and Brisbane.

![Graph showing frequency distribution over hours]

T3 nucleation mode particles of traffic origin
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- Bimodal peak at 20–40 nm and at 60–120 nm.
- At Barcelona and Madrid – cities highly influenced by road traffic emissions – the dominant peak is the finest one, whereas in Brisbane the larger peak prevails.
- Usually observed during the night time, associated with relatively clean atmospheric conditions in the urban environment.
- SB-Madrid summer nights only with a unimodal size distribution peaking in the Aitken mode at 44 nm. It is influenced by clean summer atmospheric conditions.
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- Dominant nucleation mode peak in the range 10–20 nm
- A minor size peak in the Aitken mode at 50–80 nm is attributed to background aerosols.
- Observed at midday or early afternoon more intensely during spring and summer
- Characterized by very high solar irradiance, high wind speed and low concentration of traffic pollutants
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- Prevalence at night during the colder months
- Barcelona and Madrid are unimodal although presenting different modes. BCN_NIT shows a finer mode at 361 nm, whereas MAD_NIT shows a larger size mode at 631 nm.
- In Madrid a minor peak was also seen during midday
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Data courtesy of Auckland Regional Council
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Urban aerosols in Auckland
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Differentiate between fossil carbon and biomass carbon from Residential Wood Combustion (RWC)

\[ Z \text{ ratio} = \frac{\text{BC}}{\text{CO}_2} \]

Night time mobile measurements in Glen Eden
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Comparisons:

- Other cities
- Urban/Rural
- Season
- Time of day

Correlations with:

- Other pollutant measurements
- Wind regimes
- Climatology
- Back Trajectories