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Assessment of Exposure to Airborne Particulate Matter

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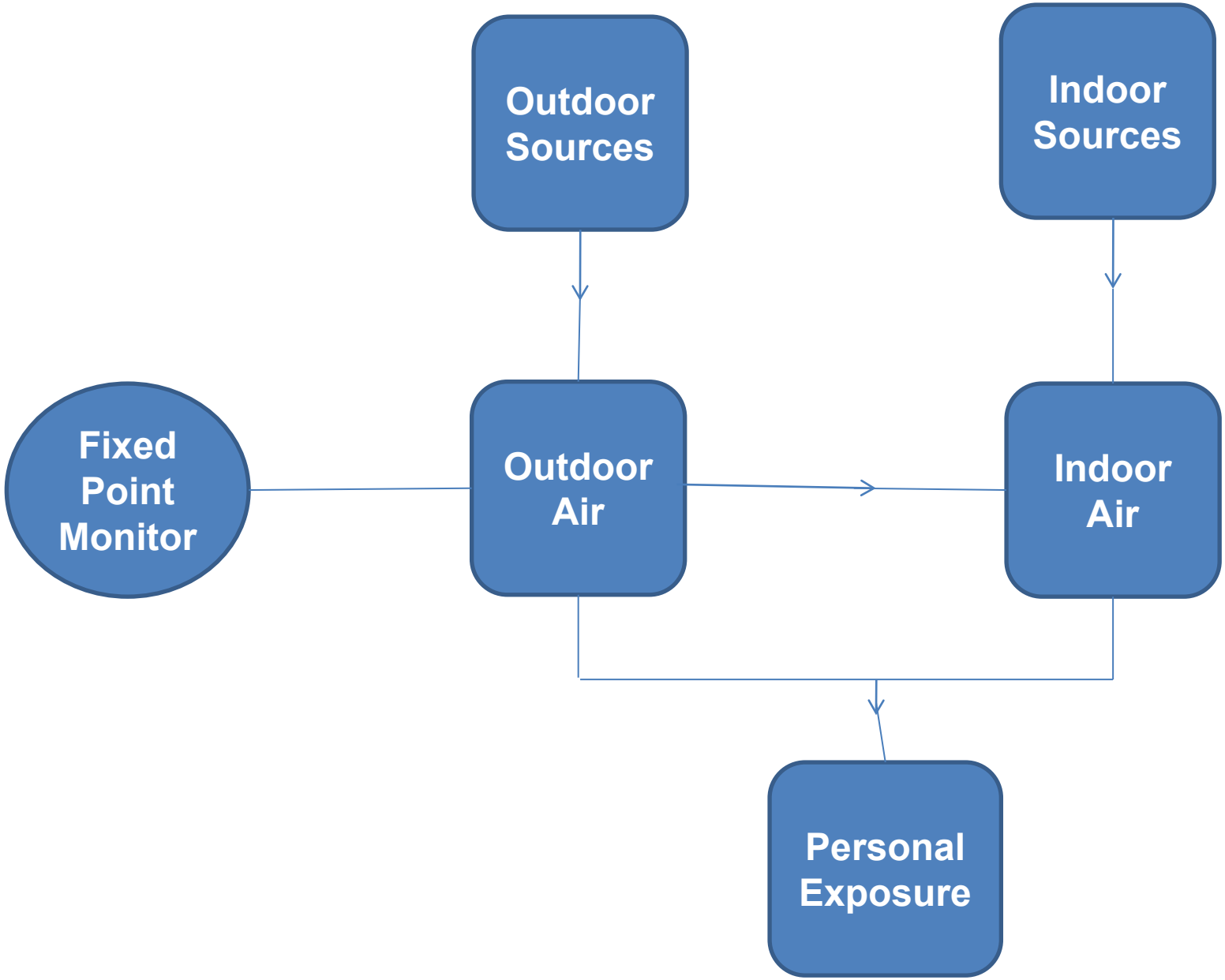
Less Simple Exposure Concept



Relevant Questions

Overall

- How well do measurements from a fixed outdoor monitoring site reflect personal exposures to $PM_{2.5}$, PM_{10} and particle number?
- How do changes in personal exposure correlate with changes in fixed site concentrations?

Sub-questions

- How spatially variable are PM_{10}, $PM_{2.5}$ and particle number concentration across a conurbation?
- How do outdoor concentrations of PM influence indoor concentrations?
- What is the influence of indoor sources?
- How well do statically measured microenvironment concentrations reflect personal exposure in that environment?

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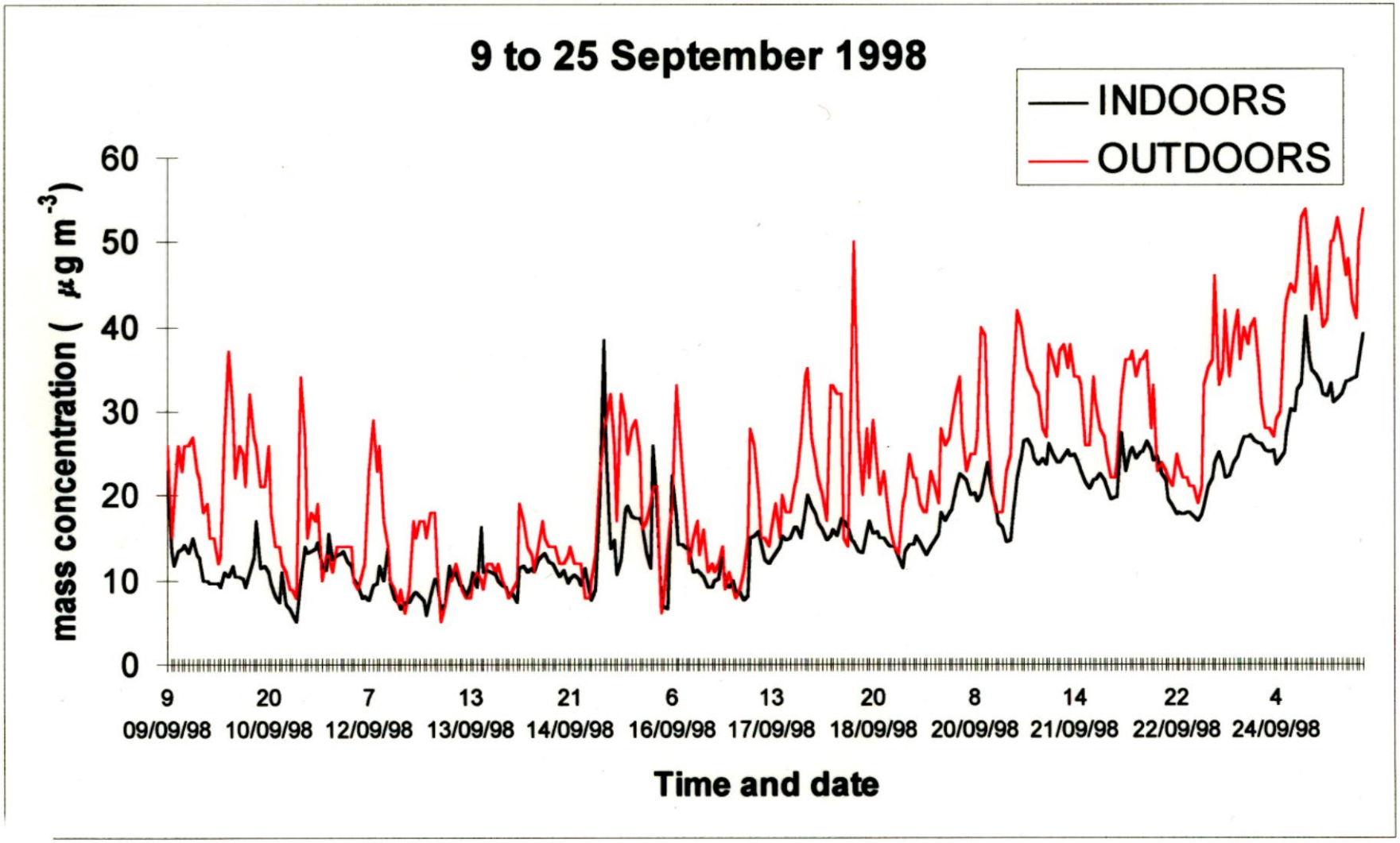
Indoor/outdoor $PM_{2.5}$ mass concentrations measured at the University of Westminster (small empty office) (mean I/0 ratio 0.75)



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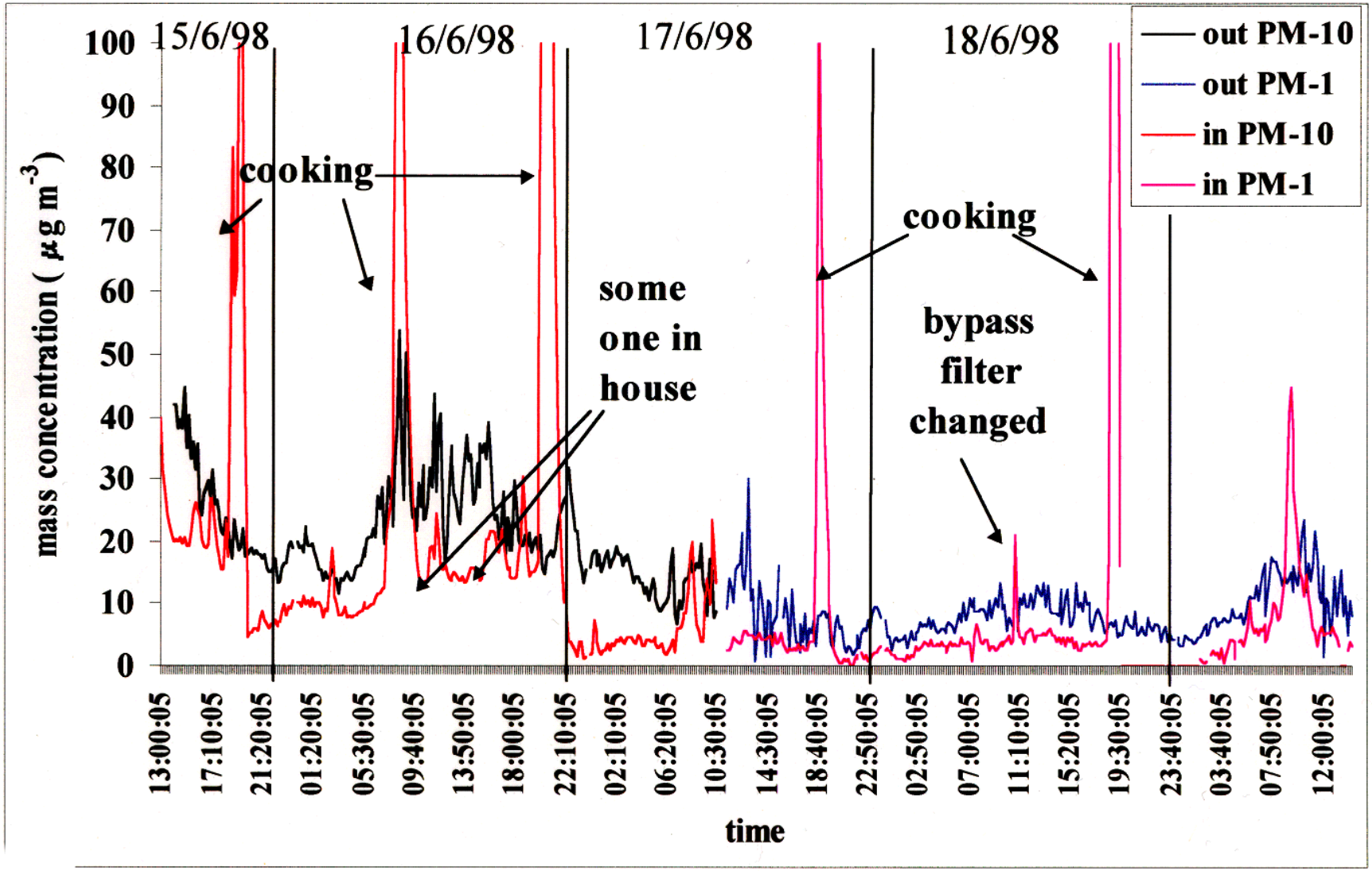
Indoor/Outdoor PM_{10} and PM_1 mass concentration measurements taken at Roadside – House 4



Personal Vs Static Samplers Indoors

- Individual subject regressions frequently poor due to small range in data; some are good
- Regressions of pooled data generally very good, but a few sampling locations appear anomalous
- Carbon monoxide

  Personal (ppm) = 0.97 Static + 0.04 (ppm)

  (R^2 = 0.92; N = 271)
- Nitrogen Dioxide

  Personal (ppb) = 1.02 Static + 2.0 (ppb)

  (R^2 = 0.80; N = 56)
- PM_{10}

  Personal (μg m^{-3}) = 1.17 Static + 17 (μg m^{-3})

  (R^2 = 0.80; N = 29)

Particle Exposures: Personal Exposure

- Measured personal exposures have been compared with micro-environment concentrations
- Where micro-environment concentrations are relatively homogeneous, they are an excellent predictor of personal exposure
- Particles show a “personal cloud” effect for PM_{10}, but less so for $PM_{2.5}$
- Overall prediction of personal exposure from micro-environment concentrations is imprecise due to the variability (temporal and spatial) within a given micro-environment

Between-site Correlations of Particle Metrics

- For *particle number*
  - outdoor – central site correlation are often quite high
  - indoor – outdoor and indoor – central site relationships are very low, unless peaks arising from indoor sources are edited from the dataset

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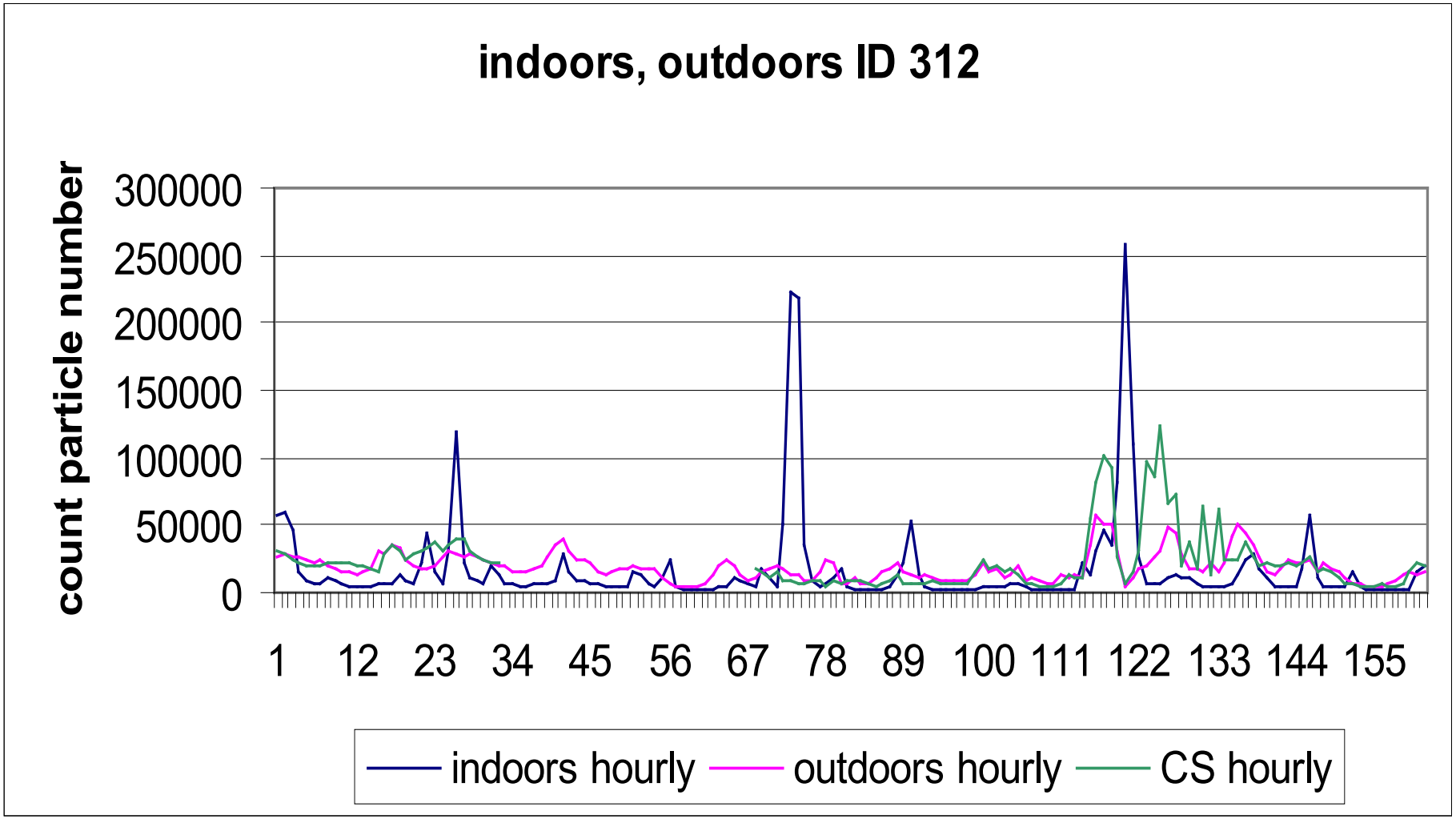
Time series of indoors, outdoor and central site particle number concentrations at the house of one subject



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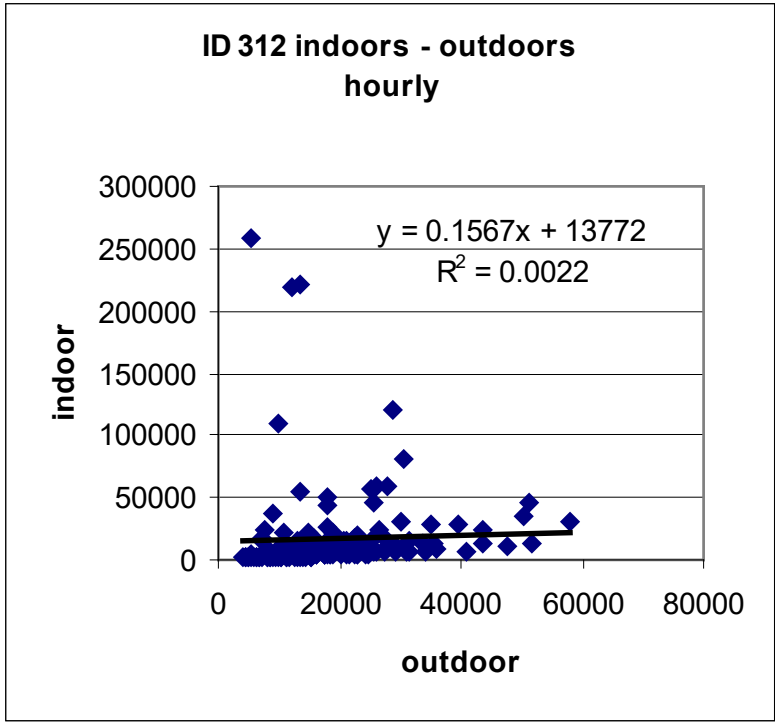
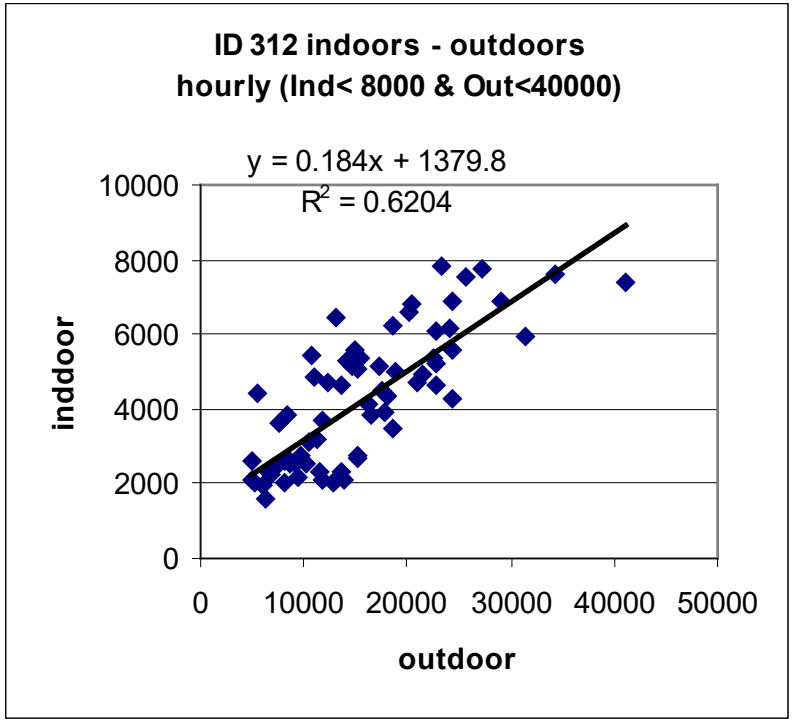
Relationship between indoor and outdoor particle number concentrations for (a) raw data, (b) data with indoor and outdoor events edited

RAW DATA



CLEARED DATA



a) Indoors vs outdoors CPC hourly data

The Longitudinal Exposure Study

Person/Day	A	B	C	D	E	Y
1						
2						
3						
.						
.						
.						
30						

Example: Measure exposures of 25 people on 30 days each

Method: Calculate individual correlations of personal exposure with outdoor concentration for each subject

Result: High median R^2 (ca 0.5 for PM_{10})

Some Conclusions

- For $PM_{2.5}$ and PM_{10} there is strong correlation between home outdoor and central site concentrations, but the home indoor correlation with central site concentrations is rather weaker.

- For particle number concentration, correlations are weaker than for $PM_{2.5}$ and PM_{10}, especially for the central site-indoor relationships.

- There is a general trend of correlations weakening as distance increases between the home and central site, but there is much scatter in the relationships.

- Within the indoor environment, personal exposures correlate closely with static monitors, but indoor sources can strongly influence indoor concentrations, and therefore personal exposures.

- There has been much speculation about the changes in PE during the Covid lockdown. Reduced traffic exposures may have been compensated by increased cooking exposures.