

Elemental Composition of Size-Segregated Particles Sampled Inside and Outside an Urban Apartment - First Results

Contribution to subproject SATURN

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Summary

There is a lack of detailed knowledge on transport of particles from the ambient to the indoor environment. Especially in urban areas it is important to quantify this transport, in order to assess human health effects of exposure to particles. In the present project size-segregated particle samples were collected in a busy street in Copenhagen and inside an apartment in the same street. The samples were analysed for their elemental composition using proton-induced X-ray emission. The results show differences between an outdoor and an indoor sample in the mass-distribution of major elements, while the relative distribution of elements in different size-fractions is quite similar indicating that the indoor particles mainly originate from the outdoor environment.

Introduction

There is a lack of detailed knowledge on transport of particles from the ambient to the indoor environment. Especially in urban areas it is important to quantify this transport, in order to assess human health effects of exposure to particles. In Denmark people are in an indoor environment 80-90% of the time and indoor concentrations must be considered in exposure calculations. A group of institutions in the Copenhagen area have initiated the TRIP project (Centre for Transport Research on environmental and health Impacts and Policy) where one of the objectives is to study the influence of outdoor pollution on concentrations in the indoor environment.

Objectives

The overall objective of this part of the TRIP project is to develop and validate a model capable of predicting indoor particle pollution from traffic based on information about outdoor particle pollution from traffic together with construction details of the building envelope and the ventilation system.

Activities

The apartment is located in a residential building in a street canyon in central Copenhagen. The apartment is fully furnished but not inhabited. The apartment is situated about 300 m from an air pollution monitoring station on the same street and less than a kilometre from an urban background monitoring station (placed on the roof of a tall building).

A variety of instruments were used for characterisation of particles inside and outside the apartment. This included measurements of particles size distributions in the ranges 6 nm to 0.7 μm and 0.5 μm to 20 μm , PM_{10} , PM_1 , and counting of condensation particles. Particles were sampled with two types of impactors; a micro-orifice uniform deposit impactor (MOUDI) and a low pressure Berner impactor. In addition concentrations of VOCs, NO_x , ozone and CO were measured. Temperature, relative humidity, pressure and air exchange rate were also determined.

This paper concerns results from elemental analysis of particles sampled with the MOUDI. The MOUDI is a 10-stages cascade impactor for sampling of particles in the size range from 18 to 0.056 μm , plus a past filter. The sampling substrate was polycarbonate filters coated with Apiezon type L grease for increased particulate adhesion. Samples were analysed by proton-induced X-ray emission (PIXE) for their elemental composition.

Results

Two measuring campaigns have been performed, one in May/June and one in October/November. During the first campaign samples were collected indoors or outdoors on a 12-hour basis, while during the second campaign samples were collected indoors on a weekly basis.

Figure 1 shows distributions of major elements in particles during two sampling periods in the summer campaign, one outdoors and one indoors. The outdoor concentration of NO_x was similar on the two days and changes in emissions or meteorological conditions cannot explain the differences in particle mass. There are some distinct differences between the two samples. First of all, the mass of major elements in the outdoor sample is 2.5 times higher than the mass of major elements in the indoor sample.

Secondly, the distribution of major elements differs significantly, since the concentrations in the 5 - 0.5 micrometer range are 2 - 4 times higher in the outdoor sample compared to the indoor sample. This observation is probably due to a combination of differences in indoor deposition rates and outdoor-indoor transport rates of different particle sizes. Other studies have noted the importance of explicit considerations of size-dependent removal mechanisms (Riley et al., 2002).

The relative size-distribution of most major elements in the particle samples is quite similar. The exceptions are iron and calcium. The fraction of iron compared to other elements is higher outdoors than indoors, especially for particle sizes larger than 0.18 micrometer. The fraction of calcium compared to other elements is higher indoors than outdoors for particle sizes larger than about 1 micrometer. The relative size-distribution of most elements indicates that the particles found in the indoor environment of an un-inhabited apartment in an urban area stem from the outdoor sources. Sources of the different elements will be discussed in the presentation.

Conclusions

Size-distribution of elements in particles were analysed in samples taken from a busy street and from inside an apartment in the same street. The results show differences in the mass-distribution of major elements, while the relative distribution of elements in different size-fractions is quite similar.

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References

Riley, W. P., T.E. Mckone, A. C. K. Lai, and W. W. Nazaroff, 2002:Indoor particulate matter of outdoor origin: Importance of size-dependent removal mechanisms. *Environ. Sci. Technol.* in press.

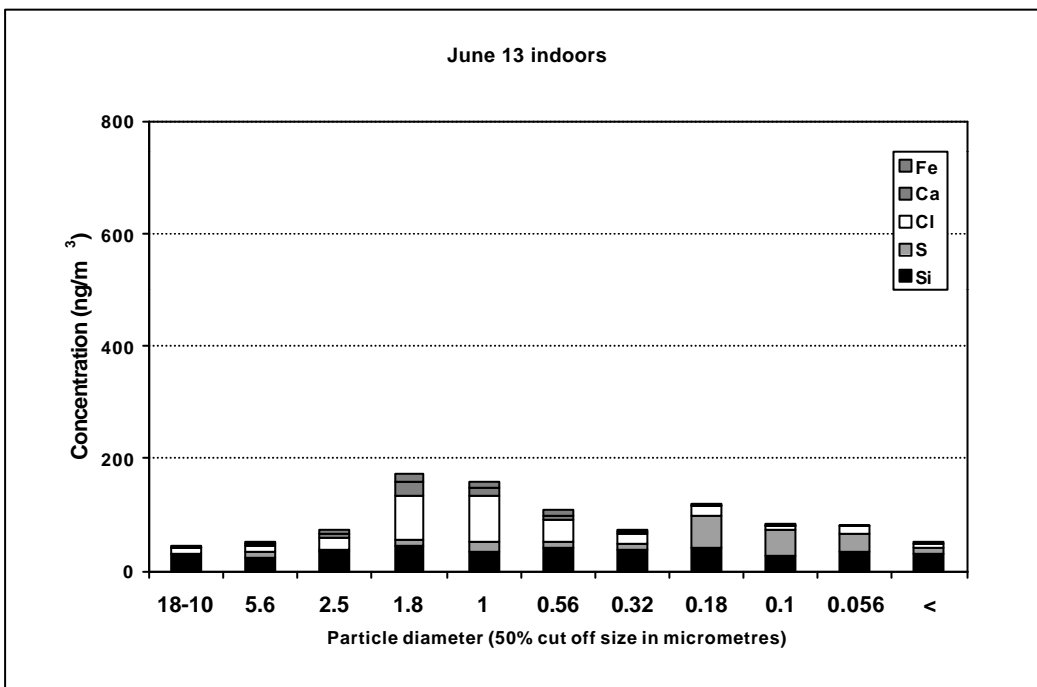
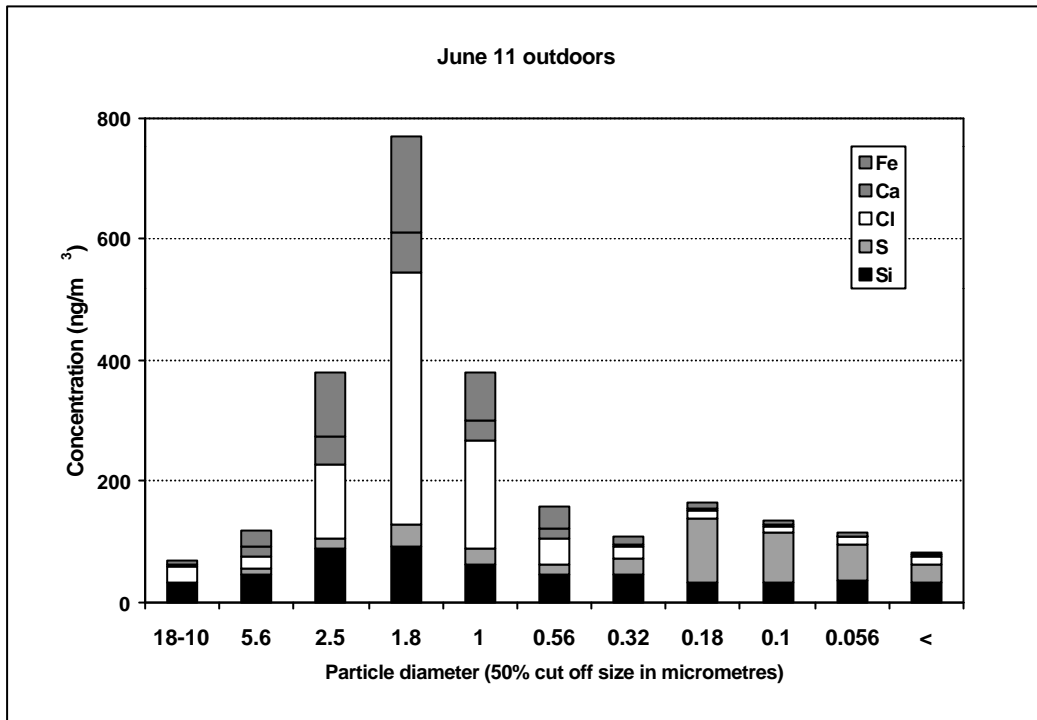


Figure 1: Distribution of major elements in an outdoor and an indoor particle sample. Both samples were collected during daytime (07:00-19:00). Particles with diameters less than 0.056 micrometer were collected on a back-up filter (<). Fe is iron, Ca is calcium, K is potassium, Cl is chloride, S is sulphur, and Si is silicon.

Aims for next year (i.e. 2002) and list of publications in 2001

Two measuring campaigns will take place at the same site to further investigate transport of particles from traffic to indoor environment.