Particle indoor to outdoor ratio separated into chemical components in an occupied residence

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Introduction

Considering that on average in developed countries we spend about 65% of our time in private homes, understanding the exposures in homes is of utmost importance. Aerosol concentrations indoors come from indoor sources, infiltrate from outdoors and can be formed from precursors both of indoor and outdoor origin. Several characteristics and processes influence the properties of aerosols indoors, among them: active indoor sources (presence of occupants), outdoor aerosol characteristics, change of chemical composition upon infiltration (from outdoors to indoors), size dependent penetration from outdoors, ventilation, tightness of the building envelope and deposition (Morawska et al., 2013). In this study, we aimed to investigate the differences in chemical composition between aerosols indoors and outdoors. We report preliminary results for 14-days period.

Methods

Indoor and outdoor measurements were performed in an occupied residence in Malmö, Sweden. The residence was naturally ventilated four-bedroom apartment (117 m²), located in a three-store concrete building surrounded by a green zone.

Time-of-Flight Aerosol Mass Spectrometer (AMS, DeCarlo et al., 2006) was used to measure particle mass loadings and size-resolved mass distributions of indoor and outdoor organic, sulphate and nitrate. Automatically switching valve alternated between indoor and outdoor lines with the time resolution of 20 and 10 minutes, respectively. Both sampling lines were mounted at the ground floor level and led to the basement where the aerosol was dried and measured by AMS. Calculated residence time of the particles in line was 1.5 minutes. Indoor sampling line was heated and insulated, additional carrier flow was used to lower the residence time.

Conclusions

Indoor to outdoor (I/O) ratios were calculated to investigate differences in chemical composition of particles inside and outside. I/O ratio for organics accounted to 5.6, for nitrate 0.2, for sulphate 0.5, and for ammonium 0.2.

The I/O ratio for organic species was high due to the contribution from indoor sources. Figure 1, illustrates elevated particle mass concentrations during occupancy period when cooking activities took place such as – frying and baking, followed by candle burning. During non-occupancy period organics loadings were low indoors - a few µg/m³.

Figure 1. Aerosol mass concentrations during non-occupancy (6:00-11:00) and occupancy (14:00-24:00) periods inside and outside of the residence.

The nitrate I/O ratio was the lowest because of its evaporation indoors i.e. dissociation of ammonium nitrate particles into gases (nitric acid and ammonia) due to higher temperature and lower relative humidity compared to outdoors. The weather conditions varied during the measurement period with T outdoors from -8.8 to 9.7 °C and RH from 32 to 100 %. Indoors, T ranged from 20.2 to 25 °C and RH from 19 to 63 %. Low value I/O ratio for non-volatile sulphate can be explained by dominating outdoor sources and reflects reduced infiltration.

In general, the differences in chemical composition of particles found indoors and outdoors becomes apparent from the results. Levels of organics in indoor environments were mainly influenced by indoor sources, thus these should not be neglected when considering possible health effects.

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