Particle Size, Mass and Chemical Transitions from an Outdoor to Indoor Environment in Prague, Czech Republic with Attention to Nitrate

Talbot, Nicholas
2015

PARTICLE SIZE, MASS AND CHEMICAL TRANSITIONS FROM AN OUTDOOR TO INDOOR ENVIRONMENT IN PRAGUE, CZECH REPUBLIC WITH ATTENTION TO NITRATE

Nick TALBOT[1,2], Lucie KUBELOVÁ[1,2],Otakar MAKEŠ[1,2], Michael CUSACK[1], Jaroslav SCHWARZ[1], Petr VODIČKA[1], Jakub ONDRÁČEK[1] ,Vladimír ŽDÍMAL[1]

[1]Institute for Chemical Process Fundamentals of the ASCR, v.v.i., Prague 6, Czech Republic, talbot@icpf.cas.cz

[2]Department of Environmental Studies, Faculty of Science, Charles University, Prague, Czech Republic.

Keywords: Indoor particulate transformation, chemical composition, dissociation behaviour, Inorganics

INTRODUCTION

In the absence of internal sources, particle number concentrations indoors are largely dependent on concentrations outdoors (Hussein *et al.*, 2006). Once indoors, particles are subjected to changes in temperature, relative humidity and different organic compounds, changing the particles physico-chemical state. (Lunden *et al.*, 2003).

As people spend most of their time indoors it's important to understand how outdoor originating particulate can migrate indoors, their relative abundance indoors and how physico-chemical processes acting upon particulate can change the overall aerosol composition. Species volatility can complicate indoor data, change mass size distribution profiles, and implant artifacts on data measurements, enhancing uncertainty on results. This research describes the findings from high temporal resolution I/O, offline and online measurements, identifies outdoor aerosol loading dynamics and describes proportional compositions indoors relative to calculated I/O ratios.

EXPERIMENTAL SETUP

Data was collected from a ground floor flat in Suchdol, Prague during summer 2014. The flat is located in a residential area in northwestern Prague about 6 km from the city centre and is recognized as a suburban background site. Particle number size distribution profiles were collected using a Scanning Mobility Particle Sizer (SMPS) model TSI 3936L consisting of a long DMA 3081 and CPC 3775. The SMPS scanned 64 channels per decade, through sizes 14.8-724nm with 3-minute up-scan, 30 second down scan and 90 second purge. An Aerodyne Compact Time of Flight Aerosol Mass Spectrometer (C-ToF AMS) ran alongside the SMPS sampling every minute, providing real-time chemical composition data (Drewnick et al., 2005).

Sequential sampling was conducted using an automated switching valve which allowed two-5 minute SMPS scans outdoors followed by two scans indoors. Two Berner Low Pressure Impactors (BLPI) were used for a size resolved chemical composition analysis with one BLPI located indoors and one outside. Substrate filters were changed every 24 hours. Meteorological data was collected from a permanent air research station located within the same ICPF compound where all measurements were collected.

RESULTS AND CONCLUSIONS

A New Particle Formation (NPF) event on the afternoon of Saturday 30th August shows a clearly defined, size resolved, outdoor-indoors infiltration [Fig 1]. This allowed for the calculation of an I/O ratio using time/size subsects during the NPF event. Ultrafine particles <40nm in diameter had the lowest *I/O* ratio at 0.45 whilst particles >80nm in diameter gave a consistent ratio between 0.65-0.7. Apparent growth rate defining particle growth between 20-50nm during the same NPF event were 4.4nm/hr outdoors.

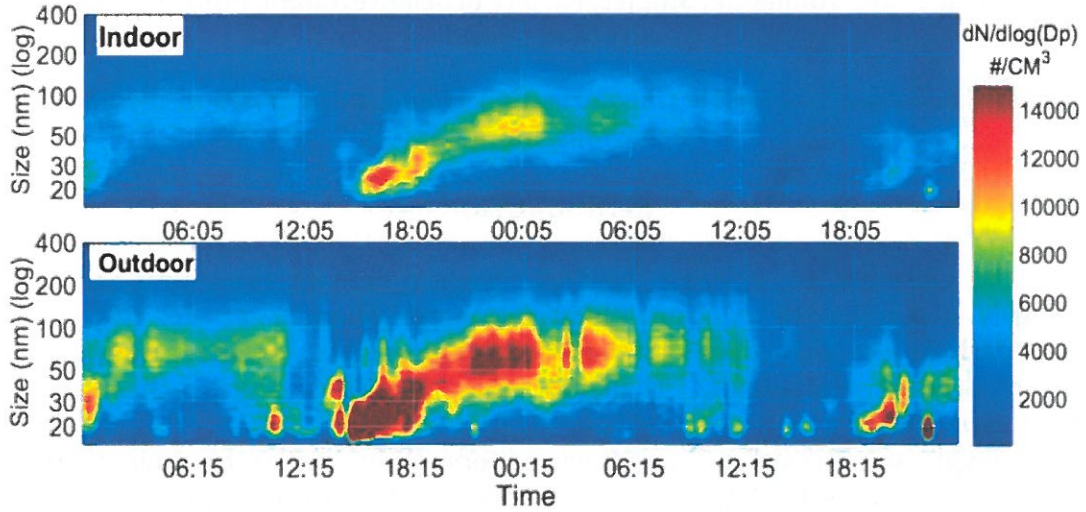

Fig 1: NPF event outdoors seen to infiltrate indoors with changing size and concentration.

Size characterization of NR-PM_1 from AMS measurements gives outdoor and indoor modal diameters for Organic matter, NH_4, NO_3 and SO_4 between 300-500nm. Further intercomparison of these non-refractory species shows indoor NO_3 concentrations were proportionally far lower than expected when considering the I/O ratio. The known volatility of NH_4NO_3 was identified as the most likely cause. Larger NO_3 mass concentration losses were observed on substrate from concurrent BLPI measurements. This difference highlights the time dependent factor when accounting for semi-volatile species.

ACKNOWLEDGEMENT

The authors acknowledge support of this work by European Union Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 315760 HEXACOMM.

REFERENCES

Drewnick, F.et al., A new Time-of-Flight Aerosol Mass Spectrometer (ToF-AMS): Instrument Description and First Field Deployment, *Aerosol Science and Technology*, 39:637-658, 2005.

Hussein T et al. 2006. "Particle Size Characterization and Emission Rates during Indoor Activities in a House." *Atmos. Environment* 40(23): 4285–4307.

Lunden M. et al. 2003. "The Transformation of Outdoor Ammonium Nitrate Aerosols in the Indoor Environment." *Atmos. Environment* 37(39-40): 5633–44.