

Diurnal variation of wood combustion related compounds and impact on urban PM₁₀

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The use of wood as renewable energy source is discussed contradictorily. On one hand the favourable CO₂ balance does not enhance the global warming problem whereas on the other hand biomass combustion significantly contributes to ambient PM mass loading and ambient concentrations of polycyclic aromatic hydrocarbons (PAH).

The study presented here was carried out in Augsburg, Germany. It consisted of four main parts: update of emission inventory for domestic heating, emission measurements, emission and aerosol dispersion modelling and ambient monitoring. The data presented focus on the results of the ambient monitoring.

High volume ambient PM₁₀ samples have been collected during the heating periods 2006/7 and 2007/8. In order to distinguish sources within the city from regional background, daily sampling was carried out simultaneously at five sites within and three sites outside of the town in February and March 2008. Samples were analysed for inorganic ions, elements, EC/OC and organic tracer compounds. During a 10 day period in February 2008 additional low volume samples were taken with 3 h time resolution and analysed for organic compounds.

At the traffic related site PM₁₀ mass concentrations were in the range of 8.7 - 93.2 µg/m³ (average 31.8 µg/m³) in winter 2006/7 and 5.1 - 98.0 µg/m³ (average 36.7 µg/m³) in winter 2007/8. The limit value of 50 µg/m³ was exceeded 15 times in winter 2006/7 and 26 times in winter 2007/8 respectively.

The concentrations of Levoglucosan, an organic tracer for biomass combustion, were in the range of 29 - 1922 ng/m³. Dehydroabietic acid, a specific tracer for coniferous wood combustion, showed concentrations in the range of 13 - 708 ng/m³. Concentrations of Potassium, which is commonly used as inorganic tracer for biomass combustion, were in the range of < 50 - 875 ng/m³.

Concentrations of all tracers for biomass combustion are highly correlated ($r > 0.85$; $p < 0.005$) independent of the year and sampling site. Just like in our long term monitoring study (Schnelle-Kreis 2007) PAH concentrations are higher correlated to source factors of solid fuel combustion (wood and coal) than to traffic related source factors.

Based on emission factors of PM and trace compounds determined within the study, the fraction of ambient PM₁₀ originating from (primary) wood

combustion particles was calculated. Highest concentrations of PM from wood combustion were found during periods with low air exchange (low wind speed and low mixing layer height). In these periods up to 4 µg/m³ higher concentrations of particles from wood combustion were found in an inner city residential area compared to the city centre. Based on the measurements near the city and in 100 m above ground level up to 75 % of the wood combustion particles could be assigned to local sources, depending on the meteorological conditions in the atmospheric boundary layer.

The measurements with time resolution of 3 h showed a clear diurnal variation with high concentrations of wood combustion tracers at night (Figure 1). Peak concentrations of more than 17 µg/m³ PM₁₀ from primary wood combustion particles were detected between 9 p.m. and midnight

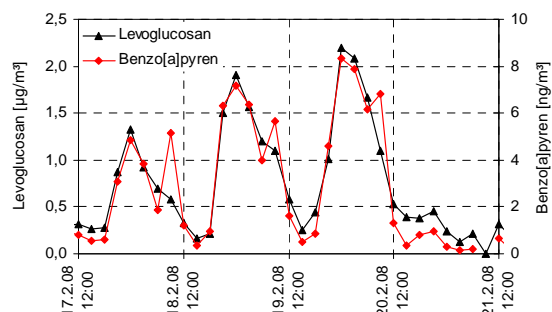


Figure 1. Diurnal variation of Levoglucosan and Benzo[a]pyren concentrations in a period with low air exchange. Traffic site. 3h samples.

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Schnelle - Kreis, J., Sklorz, M., Orasche, J., Stölzel, M., Peters, A., Zimmermann, R. (2007) *Environ. Sci. Technol.* 41, 3821 - 3828

Sklorz, M., Briedé, J.J., Schnelle - Kreis, J., Liu, Y., Cyrys, J., de Kok, T.M., Zimmermann, R. (2007) *J. Toxicol. Env. Health A* 70, 1866 - 1869