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Impact of wood combustion on urban PM_{10} concentration

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The use of wood as renewable energy source is discussed contradictorily. On one hand the favourable CO_2 balance does not enhance the global warming problem whereas on the other hand biomass combustion significantly contributes to ambient PM mass loading.

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.

As a result from the updated emission inventory for domestic heating we registered about 20,000 fireplaces for solid fuel within Augsburg. The wood consumption within the city was calculated to add up to 73,000 stere (energy equivalent 395 TJ). The total PM emission from these sources account for 46 t/a (ca. 40 % of total emissions) in Augsburg.

Ambient PM 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 different characterised sites within the city and three sites outside the town. Samples are analysed for inorganic ions, elements, EC/OC and organic tracer compounds. During a 10 day period in February 2008 additional samples were taken with 3 h time resolution and analysed for organic compounds.

At the traffic related site PM_{10} mass concentrations were in the range of 8.7 - 93.2 $\mu g/m^3$ (average 31.8 $\mu g/m^3$) in winter 2006/7 and 5.1 - 98.0 $\mu g/m^3$ (average 36.7 $\mu g/m^3$) in winter 2007/8. The limit value of 50 $\mu g/m^3$ was exceeded 15 times in winter 2006/7 and 26 times in winter 2007/8 at this site.

The concentrations of Levoglucosan, an organic tracer for biomass combustion, were in the range of 29 - 1922 ng/m^3. Dehydroabietic acid, a specific tracer for coniferous wood combustion, showed concentrations in the range of 13 - 708 ng/m^3. Concentrations of Potassium, which is commonly used as inorganic tracer for biomass combustion, were in the range of $<$ 50 - 875 ng/m^3.

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.

Within the study emission measurements (different stoves, fuels and burning conditions) were carried out. According to theses measurements the average Potassium and Levoglucosan concentrations in PM emission of domestic heating are 58 mg/g and 126 mg/g respectively. Based on these tracer concentrations the fraction of ambient PM_{10} originating from (primary) wood combustion particles was calculated. At the traffic site in average 3.4 $\mu g/m^3$ (0.2 - 15.2 $\mu g/m^3$) of PM_{10} derive from wood combustion. This corresponds to 8.4 % of the average PM concentrations at this site (range 1.9 - 30 %). 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 $\mu g/m^3$ 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 at night and peak concentrations of up to 17.5 μg/m^3 PM_{10} from primary wood combustion particles between 9 p.m. and midnight.

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