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AIR POLLUTION FROM DOMESTIC WOOD COMBUSTION

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Introduction

Air pollution from domestic wood combustion is a growing problem in the Nordic countries, since rising prices on fossil fuels lead to an increase in the use of wood stoves for domestic heating. The amount of people affected by the pollution may be rising accordingly, leading to potential negative health effects in the population (e.g. Boman et al., 2003). Previous studies have shown increased levels of $PM_{2.5}$ and other air pollutants in Danish as well as Swedish residential areas, where wood stoves were used (Glasius et al., 2007; Glasius et al., 2006; Johansson et al., 2004). In the ongoing interdisciplinary study WOODUSE a broad approach is applied, as the study investigates emissions, ambient and indoor pollution levels, human exposure, health effects, social aspects and abatement options.

Methods

Measurements of ambient $PM_{2.5}$, particle size distribution (10-700nm), soot, PAH, CO and NOx were conducted from December 2006 to March 2007 in the small village Slagslunde (approx. 350 houses) 30 km. northwest of Copenhagen. Simultaneous background measurements were conducted 500 meters west of the village (i.e. upwind in the predominant wind direction). In addition indoor measurements of soot were conducted for one week in a house where a wood stove was used every day. Simultaneous measurements were carried out outside the house (from the village monitoring station located 50 meters away) and at the rural monitoring station outside the village. Only $PM_{2.5}$ and soot measurements will be presented here.

Results and discussion

Local contributions of $PM_{2.5}$ and soot were solely attributable to emissions from wood stoves in the village, and the contribution was approximately 1.7 µg/m³ $PM_{2.5}$ and 0.16 µg/m³ soot as an average over the three month campaign (Table 1). The contribution to $PM_{2.5}$ falls between the values observed in two previous Danish studies, which showed 4.5 µg/m³ in the village Gundsømagle (Glasius et al., 2006) and 1.2 µg/m³ in the village Vindinge (Glasius et al., 2007). This is in good agreement with the expected outcome, since the amount of active wood stoves in proximity of the sampling location was higher than in Vindinge and lower than in Gundsømagle.

Table 1: *$PM_{2.5}$ and soot in the village Slagslunde and at a rural location outside the village. The local contribution is obtained by subtracting the rural level from the level in the village. $PM_{2.5}$ measurements were done with a TEOM Series 1400a, where some particle mass is lost due to heating of the airflow to about 50ºC. Soot measurements were done with a Particulate Soot Absorption Photometer, where absorption coefficient in Mm⁻¹ was converted to µg/m³ by multiplying with 10 (Andersen 2006).*

	$PM_{2.5}$	**Soot**
Slagslunde village	**10.35 µg/m³**	**0.51 µg/m³**
Rural	**8.62 µg/m³**	**0.35 µg/m³**
Local contribution (from wood burning)	**1.74 µg/m³**	**0.16 µg/m³**

The average daily variation in $PM_{2.5}$ and soot levels showed a distinct rise in the local contribution from late afternoon (approx. 15:00) to after midnight (Figure 1). This rise is a result of the wood stoves in the area being used mainly in the late afternoon and evening.

The indoor soot measurements revealed that the wood stove was a source of indoor air pollution. This is obvious in Figure 2, where the high peaks in the indoor level all occur at times when the stove was open for lighting the fire or for putting on additional wood logs. Due to ventilation in the house, the indoor levels dropped down to the initial level after a few hours.

Figure 1: Average daily variation in PM2.5 and soot levels in the village and at the rural location.

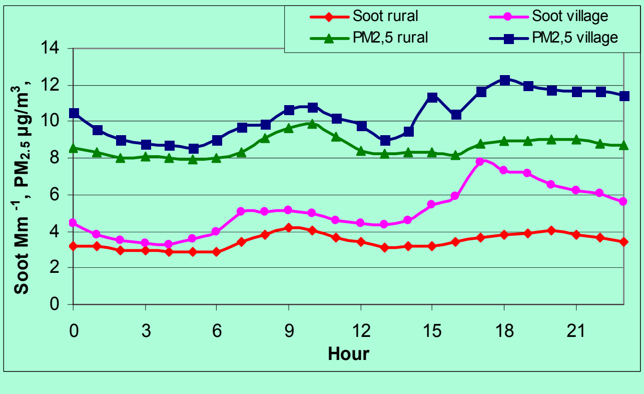
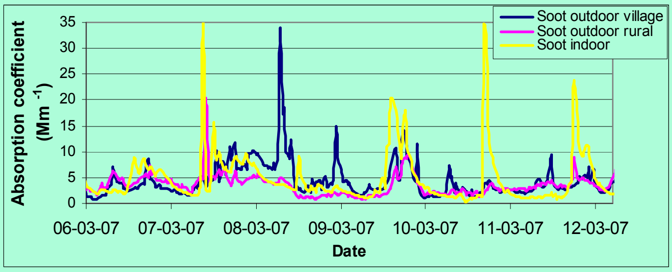


Figure 2: Soot levels indoors in a house with a wood stove, outside the house and at the rural location.



The contributions of $PM_{2.5}$ and soot from local wood combustion were greatly dependent on meteorological variables. Table 2 illustrates how the local contribution at night was doubled under stable conditions, relative to nights with neutral or unstable conditions - a result of low wind speeds and poor vertical mixing.

Table 2: *Local (wood smoke) contributions of $PM_{2.5}$ and soot under stable and neutral/unstable conditions. Under stable conditions (inversion), the contribution was approximately doubled.*

	$PM_{2.5}$-difference	**Soot-difference**
Neutral nights	**0.9 µg/m³**	**0.066 µg/m³**
Inversion nights	**1.8 µg/m³**	**0.184 µg/m³**

Wind direction also affects local air pollution from wood combustion, since the amount and proximity of sources upwind from a sampling location will vary according to wind direction. This was indeed the case in Slagslunde, illustrated in Figure 3.

Figure 3: *Wind direction dependency of local (wood smoke) contribution to the $PM_{2.5}$-level (in µg/m³) at the sampling location.*

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