Contributions of Biomass Burning and Traffic Emissions to Particulate Matter at two Urban Sites within the Ruhr Area, Germany

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Motivation & Methods

Stoves and fireplaces have been used more prevalently in industrialized countries during the last decades. In parallel, **traffic emissions** have been reduced due to the introduction of low emission zones and the implementation of more efficient engines. Consequently, an increase in relative contributions from **biomass burning** to particulate matter (**PM**) has been observed. To examine the relevance of this development within the Ruhr Area (Germany) the following measurements (16 month) and methods were used:

1. **Aethalometer® approach** *[1]*
   - Measurement: Black carbon (BC) by optical absorption at 7 wavelengths using Aethalometer® (AE-33, Magee Scientific)
   - Optical properties of traffic emissions differ from that of emissions from biomass burning → ratio of absorptions at different wavelengths are used for source discrimination

2. Mono-tracer approach for biomass burning processes using **levoglucosan** *[2]*
   - Measurement: Analyses of PM filters by ion chromatography
   - Almost exclusively emitted by cellulose combustion → $C_{levoglucosan}$ x k = PM(bio)

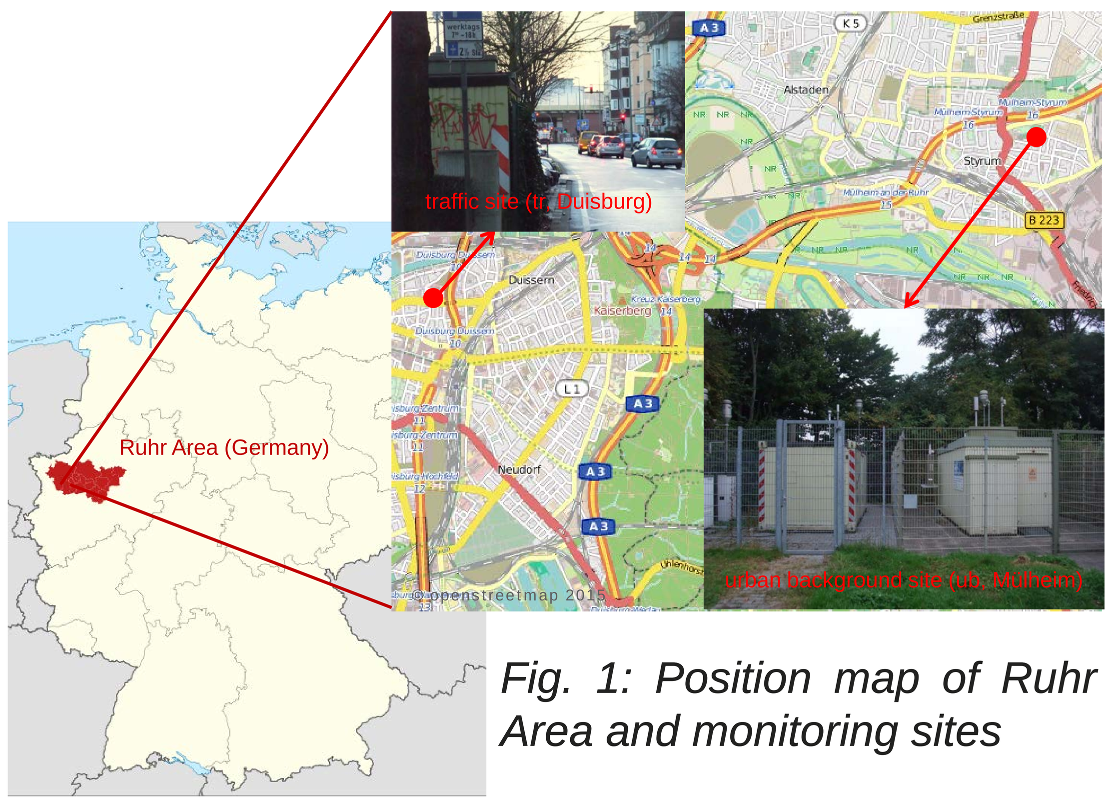

Fig. 1: Position map of Ruhr Area and monitoring sites

Results

Comparison of carbonaceous matter from biomass burning processes (with CM(bio) ~ PM(bio)) determined via different **approaches** (Aethalometer® and mono-tracer levoglucosan):

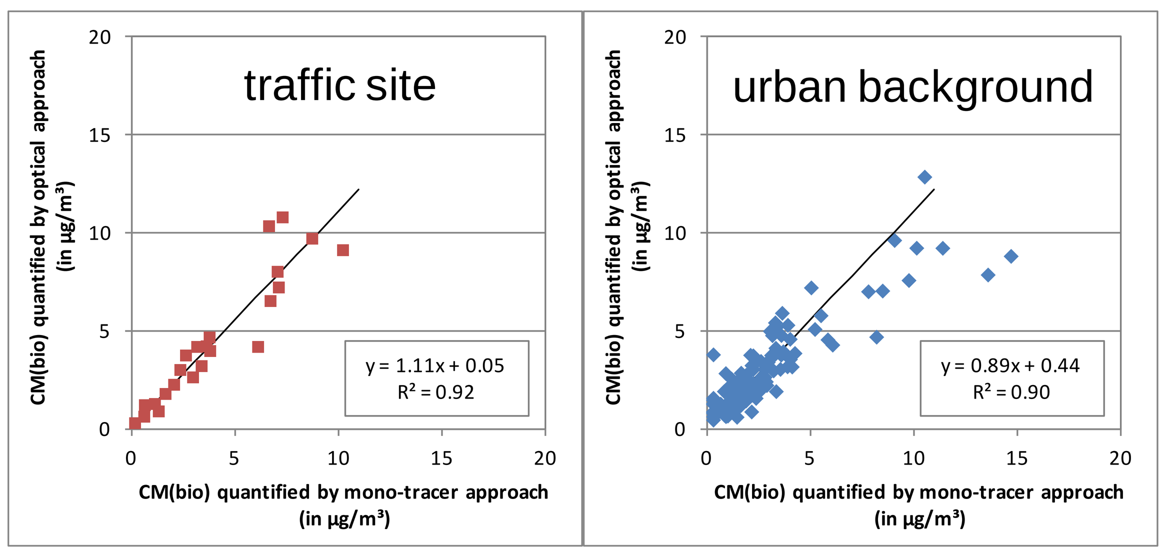

Fig. 2: Orthogonal regression of CM(bio) quantified by two different approaches (winter)

- Winter period: Good agreement (*Fig. 2*)
- Summertime: More inhomogeneous mixture of utilized fuels → lower correlation

High time resolution of BC-measurements allows for evaluation of **diurnal variations** (*Fig. 3*) influenced by:

- BC(fossil): Peaks according to rush hour
- BC(bio): Peaks attributed to heating activity

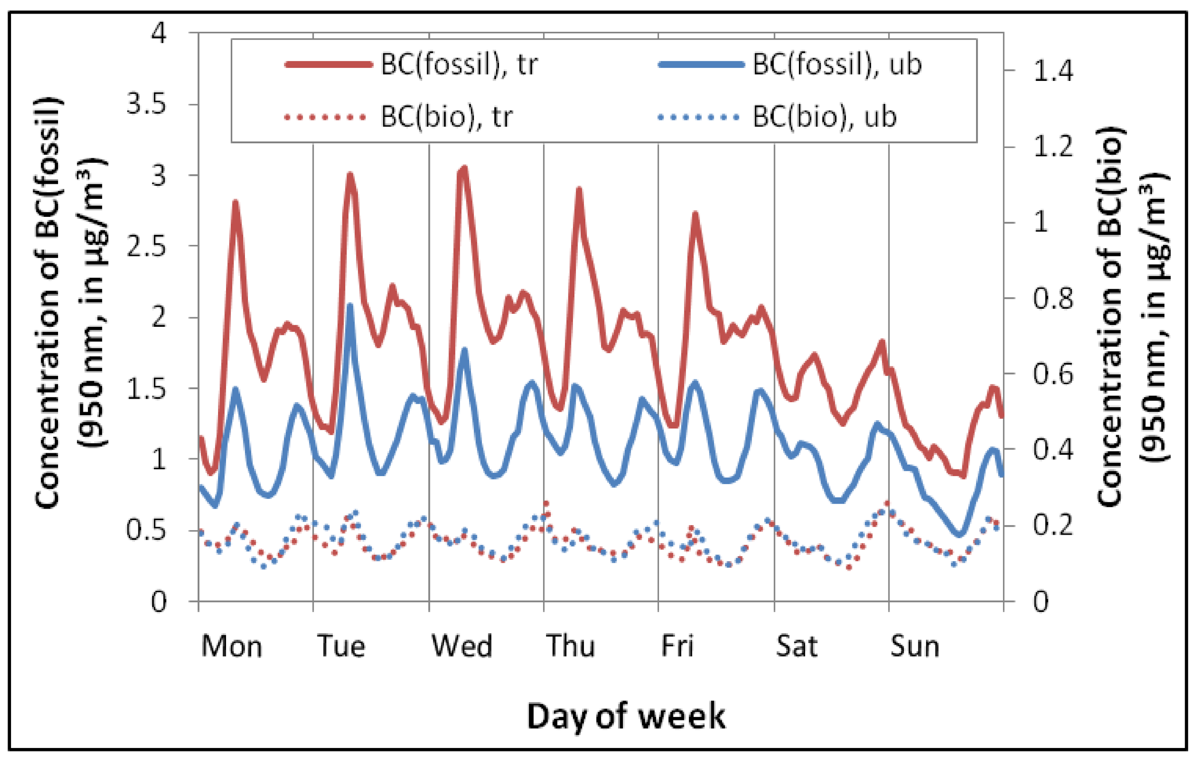

Fig. 3: Diurnal and weekly variations of BC(fossil) and BC(bio) determined by Aethalometer® approach (mean)

Distribution of **contributions to CM** quantified according to *[1]* via BC (*Tab. 1*):

- CM(fossil)[a]: No significant seasonal variation and considerably higher contributions at traffic site

[a] contributions from abrasion and resuspension not considered

- CM(bio): Almost identical at both sites accounting for higher share of PM_{10} during winter with contributions comparable to other European urban areas (e.g. *[3]*, *[4]*)

Tab. 1: Contributions of CM(fossil) and CM(bio) to PM_{10}

Share of PM_{10}	**CM(bio)**	**CM(fossil)**
	Urban background site (ub)	
Winter (Nov.–Feb.)	14.5 ± 5.7 %	9.9 ± 3.7 %
Summer (May–Sep.)	6.0 ± 4.7 %	8.7 ± 3.3 %
	Traffic site (tr)	
Winter (Nov.–Feb.)	13.3 ± 6.5 %	15.2 ± 5.2 %
Summer (May–Sep.)	5.7 ± 4.9 %	16.0 ± 5.6 %

Conclusions

Evaluation of applied methods

- Aethalometer® approach revealed plausible results regarding spatial, short-term and seasonal variations of BC and CM (fossil and bio)
- Good correlations between both approaches concerning CM(bio) → Aethalometer® approach represents convenient alternative to more work intensive and expensive filter analyses

Contribution of biomass burning emissions

- Higher spatial variance in BC(fossil) compared to almost identical contributions of BC(bio) at both sites → PM from biomass burning is homogeneously distributed on a regional scale
- CM(bio) contributed significantly to PM_{10} burden → even exceeded contributions of CM(fossil) at both sites during some winter months
- Contributions of CM(bio) to PM_{10} burden at the two observed sites were comparable to those in other European cities

References

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