Primary and Secondary Aerosol Emissions from Residential Combustion of Lignite Briquettes

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- Background -

Residential heating with solid fuels contributes substantially to ambient air pollution. Despite develepment and subsidies for renewable energies ("*Energiewende*"), Germany remains the largest producer and consumer of lignite (~100 mio t a^{-1}). However, primary and secondary aerosol from lignite are poorly understood compared to wood combustion.

Info
Germany: largest producer and consumer of lignite

- Experimental Setup -

First, two batches á 2 kg of spruce logwood were burned in an iron stove (Aduro, Denmark) with top-down ignition. Subsequently, two batches of lignite briquettes (Lausitz Energie Bergbau AG, Germany; 0.6% sulphur) were put into the glowing embers.

Info
-spruce and lignite
-ageing by OFR
-AMS, FTIR, SPI

Primary emissions were aged in a novel oxidation flow reactor (OFR) called "PEAR" [1], Spruce was previuously investigated [2] and used here for comparison. Emissions were analysed by FTIR, aerosol mass spectrometry (AMS) and single-photon ionisation mass spectrometry (SPI) [3]. SPI was equipped with a switching valve to analyse primary (blue) and secondary emissions (red) quasi-simultaneously. By using the mean residence time of the PEAR as switching time, the same volume element of primary and aged emissions can be studied. Constant addition of deuterated toluene (D3-toluene) allows quantification of organic vapours by SPI.

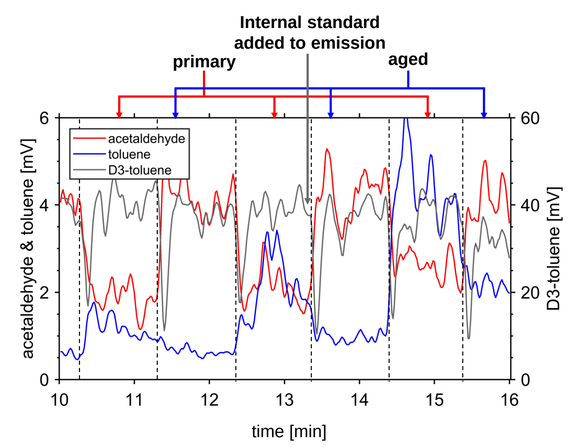
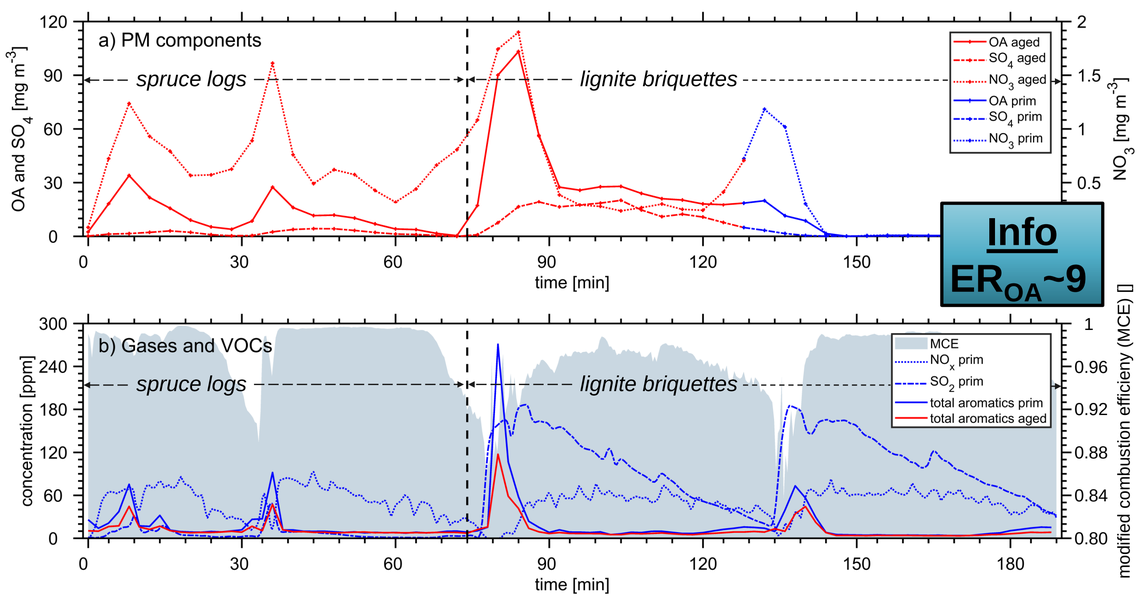


Fig. 1 Cycling of primary and secondary emissions

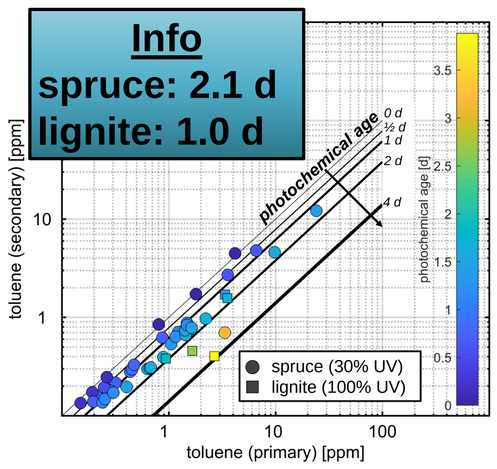
- Results & Discussion -



Info
ER_{OA}~9

Fig. 2 Primary (blue) and secondary emissions (red)

Despite high primary OA, photochemical ageing increased total OA emissions with an enhancement ratio of ER_{OA}~9. Additionally, substantial amounts of secondary sulphate and nitrate were formed.

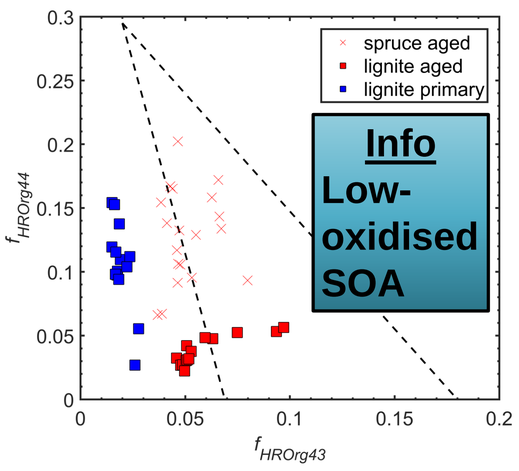


Info
spruce: 2.1 d
lignite: 1.0 d

Fig. 3 Photochemical age

Photochemical ageing shifts lignite combustion emissions into the triangular space of ambient aerosol with low carbon oxidation states.

Secondary emissions from lignite combustion has significantly lower photochemical age (1.0 d) than spruce (2.1 d; t-test: $p=3.3 \cdot 10^{-4}$), even at higher UV lamp power.



Info
Low-oxidised SOA

Fig. 4 Triangular space

- Literature -

[1] Ihalainen, et al., *submitted*
[2] Tiitta, et al., *Atm. Chem. Phys.*, 16(20), 2016
[3] Czech, et al., *Fuel*, 177, 2016

- Conclusion -

Emissions from lignite combustion form high amounts of low-oxidised secondary organic and inorganic aerosol during photochemical ageing.

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