Fugitive particle emissions from steel making: source characteristics and local air quality impact investigated with a mobile laboratory

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Industrial stack emissions are largely regulated and therefore typically reasonably well known. However, much less is known on the characteristics and local impact of fugitive emissions which can originate from multiple sources in industrial facilities. The focus of this study is the investigation of fugitive particulate emissions from sources on integrated steel plants, both in terms of emission characteristics and of their impact onto the air quality in the area around such sites.

The highly time resolved measurements within this study were performed using the mobile aerosol research laboratory MoLa (Drewnick *et al.*, 2012). MoLa provides state-of-the-art instrumentation to determine aerosol number (d_p > 2.5 nm) and mass (PM_1, $PM_{2.5}$, PM_{10}) concentrations, particle size distributions (d_p = 6 nm – 32 µm) and chemical composition of the sub-micron aerosol. In addition several trace gases and all relevant meteorological variables are measured.

For determination of fugitive emission source characteristics, stationary measurements of the ambient aerosol were performed within the steelworks several tens to several hundred meters downwind of the individual facilities. The distribution of air pollutants in the vicinity of the plant and their impact onto local air quality were determined by applying a combination of stationary and mobile measurements, both downwind the steelworks and in the unpolluted background.

In order to extract the best possible information from the Aerodyne HR-ToF-AMS mass spectra different approaches have been used. In addition to the determination of the standard species, PMF was applied to separate the organic aerosol into fresh combustion-related and oxygenated (i.e. aged) fractions. Thorough analysis of the high-resolution mass spectra provided information on aerosol components like iron, rubidium and zinc halogenides as well as lead, all not included in the standard analysis procedure of the instrument.

Measurements downwind of blast furnaces, coke ovens, a BOS (basic oxygen steelmaking) plant, ore and coal stockyards and a vehicle movement area were used to determine the respective fugitive emission source characteristics. Due to the close proximity of multiple sources on an integrated steel plant, miniscule variations in wind directions can cause the advection of background air or of emissions from other sources to the measurement site, resulting in systematic biases in integrating measurements. Therefore, the combination of highly time-resolved wind and pollutant measurements is necessary to reliably determine the source contribution to the locally observed ambient aerosol.

A total of more than 1300 km of mobile measurements in the vicinity of two steel plants was performed to determine the concentration distributions for multiple aerosol and trace gas variables in the respective areas. After removal of data contaminated by local sources (e.g., vehicles in front of MoLa) pollutant concentrations along the driving tracks were calculated. Using an extrapolation and interpolation algorithm that accounts for the different transport characteristics parallel and perpendicular to the wind direction, two-dimensional distribution maps were calculated for every pollutant measured with MoLa (e.g., Fig. 1). For days where wind directions did not change strongly over the time of the measurement this procedure provided valuable information on the impact of the steelworks emissions onto the local air quality in the vicinity of the plant.

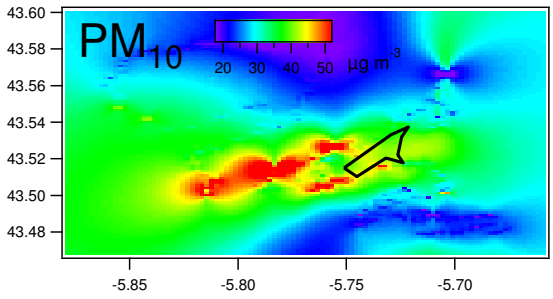

Figure 1. Distribution of PM_{10} in the vicinity of a steel plant. Two separate sources of PM_{10} on and near the steelworks (black framed area) can be distinguished.

Additional stationary measurements in the unpolluted background and within the emission plume were performed. These data were used to determine the background aerosol characteristics as well as the temporal variability of the steelworks impact onto various locations.

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