Multi Seasonal Functional Group Analysis by FT-IR Spectroscopy of Atmospheric Aerosol in Zurich

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Keywords: Atmospheric aerosols, FT-IR, functional groups.
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Atmospheric particulate matter (PM) has been associated with increased morbidity and mortality, reduced visibility, and is one of the least understood components of the climate system. Organic matter (OM) constitutes a substantial fraction (up to 80%) of PM (Lim and Turpin 2002), and its quantification and characterization can help in understanding the impact of atmospheric aerosol on health and climate. OM is a complex mixture of thousands of different organic molecules that vary in structure and physicochemical properties (Hamilton et al. 2004). The functional group (FG) representation simplifies the chemical analysis of OM by providing information about properties like volatility and hygroscopicity and can be used for overall organic matter and organic carbon (OC) quantifications, and its apportionment by source class (Russell et al., 2011).

We use the Fourier transform infrared (FT-IR) absorbance spectra of atmospheric aerosol ($PM_{2.5}$) collected on Teflon filters to characterize the chemical composition of OM using the FG representation. Teflon filters are collected daily at the National Air Pollution Monitoring Network (NABEL) station in Zurich (Switzerland) from the 1st of April 2016 (until the 31st of March 2017). We processed the spectrum of each sample to correct the drift of the baseline and substrate interference using the method proposed by Kuzmiakova et al. (2016). We quantify the functional group composition of the ambient samples by fitting individual Gaussian line shapes (top panel in Fig. 1). We quantified alcohol COH, carboxylic COOH, alkane CH, carbonyl CO, and amine NH functional groups, as described in Takahama et al. (2013). We use the FT-IR spectra to apportion OM and FGs associated with traffic emission and wood burning using collocated measurements of black carbon (BC – light absorption of $PM_{2.5}$ measured at multiple wavelengths).

An example of FG study is shown in Fig. 1 for a sample collected in November 2016. The FG distribution shows that alkane CH accounts the 39% of the total OM. The significant contributions of alcohol and carboxylic acid (16% and 29% respectively) exemplifies the influence of processed aerosol from surrounding regions affecting the $PM_{2.5}$ in Zurich. Moreover, the high OM/OC ratio (2.01) with substantial contributions from alcohol, and carbonyl FGs are consistent with those found in biogenic or wood-burning samples (Russell et al., 2011). These sources have also been reported in previous studies of Zurich PM by carbon isotope analysis Szidat et al. (2004) and aerosol mass spectrometry (Canonaco et al., 2015).

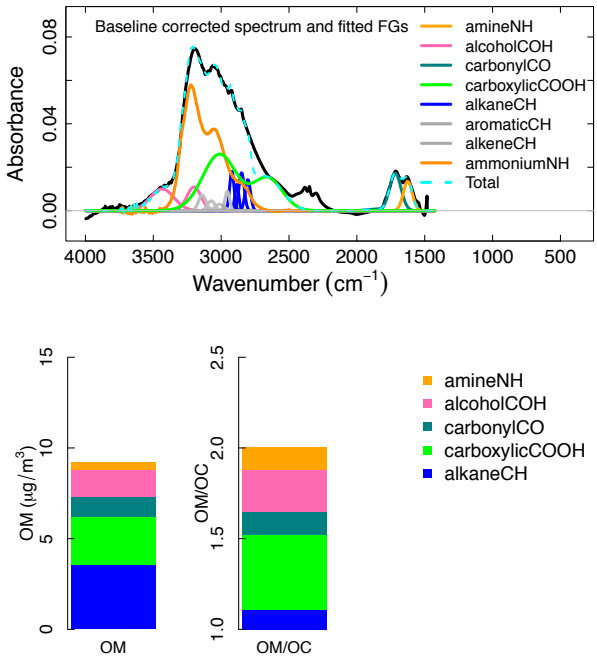

Figure 1. Example of FG analysis by FT-IR spectroscopy of atmospheric aerosol collected on one Teflon filter. Top panel: baseline corrected spectrum with fitted FGs. Bottom panel: FG contributions to total OM and their heteroatom contributions to the total OM/OC ratio (Takahama and Ruggeri, 2016).

The authors acknowledge funding from the Swiss Federal Office for the Environment (FOEN, P135-1008) and EPFL.

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