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On the Possibility of Real Time Characterisation of Ambient Toxicity Using Multi-Wavelength Photoacoustic Instrument

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Abstract : According to the best knowledge of the authors, here we experimentally demonstrate first, a quantified correlation between the real-time measured optical feature of the ambient and the off-line measured toxicity data. Finally, using these correlations we are presenting a novel methodology for real time characterisation of ambient toxicity based on the multi wavelength aerosol phase photoacoustic measurement. Ambient carbonaceous particulate matter is one of the most intensively studied atmospheric constituent in climate science nowadays. Beyond their climatic impact, atmospheric soot also plays an important role as an air pollutant that harms human health. Moreover, according to the latest scientific assessments ambient soot is the second most important anthropogenic emission source, while in health aspect its being one of the most harmful atmospheric constituents as well. Despite of its importance, generally accepted standard methodology for the quantitative determination of ambient toxicology is not available yet. Dominantly, ambient toxicology measurement is based on the posterior analysis of filter accumulated aerosol with limited time resolution. Most of the toxicological studies are based on operational definitions using different measurement protocols therefore the comprehensive analysis of the existing data set is really limited in many cases. The situation is further complicated by the fact that even during its relatively short residence time the physicochemical features of the aerosol can be masked significantly by the actual ambient factors. Therefore, decreasing the time resolution of the existing methodology and developing real-time methodology for air quality monitoring are really actual issues in the air pollution research. During the last decades many experimental studies have verified that there is a relation between the chemical composition and the absorption feature quantified by Absorption Angström Exponent (AAE) of the carbonaceous particulate matter. Although the scientific community are in the common platform that the PhotoAcoustic Spectroscopy (PAS) is the only methodology that can measure the light absorption by aerosol with accurate and reliable way so far, the multi-wavelength PAS which are able to selectively characterise the wavelength dependency of absorption has become only available in the last decade. In this study, the first results of the intensive measurement campaign focusing the physicochemical and toxicological characterisation of ambient particulate matter are presented. Here we demonstrate the complete microphysical characterisation of winter time urban ambient including optical absorption and scattering as well as size distribution using our recently developed state of the art multi-wavelength photoacoustic instrument (4λ-PAS), integrating nephelometer (Aurora 3000) as well as single mobility particle sizer and optical particle counter (SMPS+C). Beyond this on-line characterisation of the ambient, we also demonstrate the results of the eco-, cyto- and genotoxicity measurements of ambient aerosol based on the posterior analysis of filter accumulated aerosol with 6h time resolution. We demonstrate a diurnal variation of toxicities and AAE data deduced directly from the multi-wavelength absorption measurement results.

Keywords : photoacoustic spectroscopy, absorption Angström exponent, toxicity, Ames-test
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