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Online Quantification of Reactive Oxygen Species (ROS) in Atmospheric Aerosol: results from field and laboratory experiments

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Epidemiological studies have linked atmospheric aerosol levels with mortality and hospital admissions due to respiratory and cardiovascular disease. It is often hypothesised that these negative health effects are due to particle-bound reactive oxygen species (ROS). Established methods to quantify ROS mostly rely on particles being collected on filters, followed by subsequent extraction steps and chemical analysis. These methods usually have time resolutions of hours to days, which can limit the comparison with other fast changing components in the atmosphere. In addition, a long delay between collection of particle-bound ROS and their analysis might underestimate true total ROS concentrations because many ROS components are highly reactive and thus short-lived.
To overcome these limitations, we developed an instrument to allow on-line, continuous measurement of particle-bound ROS using the fluorescence probe 2'7'-dichlorofluorescein (DCFH), in conjunction with horseradish peroxidase (HRP), via fluorescence spectroscopy. A high time resolution of about 5min allows tracking fast changes in the atmosphere e.g. changes in meteorological conditions or traffic pattern. We show that up to 40-80% of ROS in organic aerosol has a short lifetime of only about 15min, emphasising the need for fast online techniques to obtain reliable ROS quantification data.
We will present online ROS analyses of secondary organic aerosol generated in laboratory chamber experiments and compare these with ambient urban measurements, which show pronounced diurnal cycles with maxima in early afternoon. Online data will also be compared with offline ROS analysis to highlight the differences of these two measurement approaches.