

Tuning sampling and analysis strategies for UFP: Laboratory and field tests with selected anthropogenic and biogenic marker components

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Weather, climate, and air quality are impacted by airborne particles. Ultrafine particles (UFP; diameter less than 100 nm) account for the majority, by number, of these particles, originating from both anthropogenic and biogenic sources. While secondary UFPs are formed by the oxidation, condensation, and multiphase chemical reactions of gaseous precursors, primary UFPs are directly released to the atmosphere. Whether or not the UFPs pose a risk to human and/or environmental health strongly depends on their size and chemical composition. Therefore, accurate information on the origins and atmospheric transformation of airborne UFPs is crucial for evaluating and devising efficient control methods. A precise chemical investigation of UFPs can help to understand the underlying atmospheric processes and their impact. However, attempts to analyze their chemical composition in the atmosphere are still rare. Considering the low mass, partial volatility and dynamic character of UFPs, it is a great challenge to separate, collect and analyze them in the atmosphere.

Impactors are useful tools to separate and collect environmental particles from the air with the aim of analyzing their chemical composition. After careful physical characterization of different types of cascade impactors regarding their cut-off characteristic, pressure drop and sampling volume, we report on size dependent UFP sampling during the winter season in urban and rural areas in Bavaria, Germany. Different commonly applied impactors were operated simultaneously for different time-periods, partly after their optimization for the separation and collection of the ultrafine fraction. The chemical composition of the collected UFPs was examined off-line with various chromatographic analytical methods such as thermal desorption (TD) gas chromatography (GC) - mass spectrometry (MS), high performance liquid chromatography (HPLC) MS and HPLC - fluorescence detection (FLD) were used for offline chemical analysis.

For testing our methods, we focused on specific marker components of anthropogenic (Phenanthrene, 2-Hydroxyphenanthrene, Pyrene, 1-Hydroxypyrene, Benzo(a)pyrene and Levoglucosan) and biogenic sources (Terebic acid, Terpenylic acid, Pinic acid and Pinonic acid). Due to the low mass of UFPs and the variety of polarity of the chosen marker components, we developed suitable extraction methods adapted to the different analytical requirements. Our aims are first, to draw comparisons between the performance of the impactors, second, to investigate different analytical methods for chemical UFP analysis and third, to provide data on the spatial distribution.

The initial results of the physical characterization of various impactors indicate that not all devices are suitable for separating and collecting UFPs concerning our chosen marker components. Factors such as inaccuracies in the cut off characteristics, pressure drop, sampling volume and handling play a role in the selection of the impactor. Initial results show that, based on the deployed impactor, there are variations in the chemical composition of the size class of ultrafine particles. Differences in chemical composition could also be identified by applying the different analytical methods. This highlights, among other things, the need to compare and standardize the methods for UFP characterization.

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