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Catch me if you can: Evaluating sampling methods for airborne ultrafine particles' composition analysis

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Airborne particles affect air quality, weather and climate. The continuing urbanization is expected to expose a growing fraction of the world's population to still increasing levels of anthropogenic emissions of airborne particles and precursors of secondary aerosols. These anthropogenically emitted particles are dominated in number by ultrafine particles (UFP; diameter less than 100 nm), which therefore are common in urban air. Their size and chemical composition determine whether the particles impose a risk to human health or the environment. Thus, in-depth knowledge about airborne UFPs' sources and atmospheric fate is essential for environmental risk assessment. A detailed chemical analysis of UFPs aids to better understand environmental processes in the atmosphere and possible effects on human health.

Despite the need of learning more about the origin, behaviour, mobility, fate, and toxicity of UFPs, attempts to analyze their chemical composition in the atmosphere are still rare. Considering their low mass, partial volatility and dynamic character, it is still a great challenge to separate, catch and analyze UFPs in the atmosphere.

Impactors are important tools to separate and collect environmental particles from the air with the aim of analyzing their chemical composition. Herein, we report our evaluation of commercially available and frequently deployed cascade impactors for their applicability of sampling airborne UFPs. We tested the following criteria: (1) A precise size separation or cut□off in the ultrafine range to enable size-dependent chemical analysis, (2) The collection of the greatest as possible particle mass (high sampling volume) while minimizing evaporation losses of semi-volatile fractions (small pressure drop). Therefore, different impactors were connected in line between a customizable particle generation source, a flow reactor for dilution, mixing and ageing, and a mobility particle size spectrometer (MPSS). So far, our results indicate a significant variability among impactors of the same model and highlight the difficulty of combining all these requirements in one device. However, after careful physical characterization, we developed a strategy to optimize the particle sampling for atmospheric UFPs chemical composition analysis.

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