Continuous Measurement of the Chemical Composition and Physical Properties of Ultrafine Particulate Matter ($PM_{0.1}$)

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Abstract

Ultrafine particles (diameter less than 100 nm) can translocate to sensitive organs of the human body (e.g., brain) and are thus primary suspects for enhanced negative health effects on humans. Measuring the chemical composition and physical properties of ultrafine particles continuously and accurately is particularly challenging because of their typically low mass concentration ($PM_{0.1}$) and susceptibility to interference from larger particles during the measurement processes. The few past $PM_{0.1}$ chemical composition studies have used cascade impactors. However, this method for $PM_{0.1}$ mass concentration measurement offers low temporal resolution, demands substantial labor, and its results might be affected by larger particles which have significantly more mass. The Aerodynamic Aerosol Classifier (AAC, Cambustion) has the capability to function as a low-pass separator with selectable cut-off. We used the AAC, to separate $PM_{0.1}$ from larger particles, followed by instruments that provide continuous composition measurements. An SP^2XR (Droplet Measurement Technologies), for continuous black carbon measurements, a Xact 625i (SailBri Cooper, Inc)., for semi-continuous multi-metals measurements and a High-Resolution Time of Flight Aerosol Mass Spectrometer (HToF-AMS, Aerodyne Research Inc.), for $PM_{0.1}$ organic aerosol, particle density and source-apportionment analysis. The AAC was also combined with a Scanning Mobility Particle Sizer (SMPS) to provide information about the $PM_{0.1}$ density and shape factor.Ambient $PM_{0.1}$ characterization measurement was conducted in different seasons in a suburban area in Greece. Most of the $PM_{0.1}$ (around 70%) was organic, with sulfates also representing a significant fraction. Black carbon contributed 5-10% on average, while the most prominent elements were Ca, K, Cl, Br, Fe, Zn and Ti. The temporal variation of concentrations, composition, and sources have been analyzed and will be discussed.

Early Career Scientist

YES, I am an early career scientist.