Development of a single-particle technique to study insoluble residues from isoprene-derived secondary organic aerosol in droplets

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Abstract

Atmospheric aerosols are key contributors to cloud condensation nuclei (CCN) and ice nucleating particle (INP) formation, which can offset positive radiative forcing. Aerosol particles can undergo many cycles of droplet activation and subsequent drying before their removal from the atmosphere through dry or wet deposition. Cloud-aerosol-precipitation interactions are affected by cloud droplet or ice crystal formation, which is related to the physicochemical properties of aerosol particles. Isoprene-derived secondary organic aerosol (iSOA) is an abundant component aerosol and has been previously found in INPs and cloud water residues, and it includes both soluble and insoluble residues in its particle matrix. Currently, most of our understanding of iSOA is derived from studying the soluble residues, but there has been a measurement gap for characterizing the insoluble residues. These measurements are needed as previous research has suggested that insoluble components could be important with respect to CCN and INP formation.
Herein, a unique approach is utilized to collect the insoluble residues of SOA in ~3 μm droplets collected from a Spot Sampler from Aerosol Devices, Inc. iSOA is generated by reactive uptake of IEPOX onto acidic seed particles (ammonium sulfate + sulfuric acid) in a humidified atmospheric chamber under dark conditions. Droplets are impacted directly on a substrate or in a liquid medium to study the roles of insoluble residues from both single-particle and bulk perspectives. A suite of microspectroscopy techniques, including Raman and optical photothermal infrared (O-PTIR) spectroscopy, are used to probe the chemical composition of the residues. Atomic force microscopy – photothermal infrared (AFM-PTIR) spectroscopy and Nanoparticle Tracking Analysis (NTA) are used to measure the size distributions of the residues. These insights may help understand the properties of residues from cloud droplet evaporation and subsequent cloud-aerosol-precipitation interactions in the atmosphere.