Atmospheric particles: Viscosity, phase, and response to relative humidity

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Atmospheric particle phase, viscosity, and mixing state are inherently intertwined with one another. How particles change and evolve, particularly as a function of relative humidity, is crucial for evaluating the lifecyle of atmospheric aerosols. One method to obtain insight into particle phase/viscosity uses scanning transmission x-ray microscopy/near edge x-ray absorption structure spectroscopy (STXM/NEXAFS) to measure the total carbon absorption of individual collected particles as a function of particle size. A comparison of field samples with laboratory generated alpha-pinene and limonene secondary organic aerosols (SOA) shows that these laboratory SOAs are less viscous than field samples. A second method to examine particle viscosity is tilt-angle scanning electron microsopy imaging. This method has recently been used to verify semi-solid particles from the Southern Great Plains site.

The third method, and the primary focus of this presentation employs a creative approach with quartz crystal microbalance techniques to examine particle phase and viscosity during water vapor uptake. First, these experiments provide direct measurments on the mass based water vapor uptake. By additionally quantifying the coupling of these aerosols to the substrate and changes in the coupling as a function of relative humidity, may allow determination of particle viscosity as a function of relative humidity. Here, we present the general method and characterization using salts, sugars, and laboratory generated SOA to illustrate the potential utility of this technique.