Mechanical Engineering Department Seminar

3:35pm February 10, 2016
1130 Mechanical Engineering
111 Church Street SE, Minneapolis, MN 55455

Exploring the Morphology and Ice Nucleation Properties of Complex Atmospheric Aerosols Using Individual Particle Techniques

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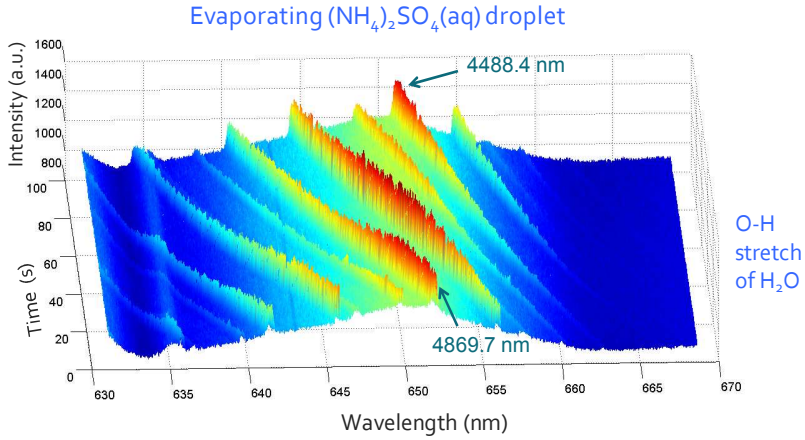
We develop real-time laser based instrumentation to determine the size, composition, and morphology of individual aerosol particles. These include laser ablation single-particle mass spectrometry, and aerosol optical tweezers with cavity enhanced Raman spectroscopy. These sensitive analytical techniques allow us to further our understanding of the interplay between particle size, composition, phase separations, and morphology. We then examine how these physicochemical properties control the resulting heterogeneous chemical kinetic and ice nucleation properties of realistic complex particulate matter in the atmosphere. A major focus is exploring how the atmospheric chemical evolution of particles alters their ability to nucleate ice and cause clouds to glaciate. Frozen clouds have a net climate warming effect in contrast to the cooling effect of liquid clouds, and most precipitation over land initiates from the ice cloud phase. This talk will focus on our discoveries of the unstable freezing properties of biological ice nucleants, and the significant effects of chemical aging on the ice nucleation ability of smoke particles from biomass burning. We will also present our advances of the aerosol optical tweezers technique to perform the first experiments on tweezed supercooled droplets at subzero temperatures. Studies of the morphology and phase separations that occur in complex mixed organic/inorganic particles observed using the optical tweezers will also be discussed.



Bio: Ryan Sullivan is an assistant professor in the Departments of Chemistry, and Mechanical Engineering at Carnegie Mellon University, and a faculty member in the Center for Atmospheric Particle Studies. He obtained his bachelors in chemistry from the University of Toronto, and his doctorate in chemistry from the University of California, San Diego. Before moving to Carnegie Mellon University in 2012 he completed his postdoctoral research in atmospheric science at Colorado State University. Ryan is the recipient of a Faculty Early Career Development (CAREER) award from the National Science Foundation, and the National Academy of Science's Cozzarelli Prize. His research group at CMU develops laser-based analytical techniques for real-time analysis of individual aerosol particle composition. These include laser ablation single-particle mass spectrometry, aerosol optical tweezers, and microfluidic devices for ice nucleation research. The multi-phase chemical evolution of biomass burning aerosol from wood smoke is a major current focus. Ongoing experimental investigations include the alteration of the ice nucleation properties of smoke particles induced by chemical aging; and the activation of photo-labile chlorinated gases from heterogeneous reactions of nitrogen oxides with chloride salts emitted in the smoke.