

K.001 Going Through a Phase: Particulate Water in Atmospheric Aerosol.

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Abstract:

The water content of atmospheric aerosols controls many properties including their ability to catalyze heterogeneous chemical reactions, their impact on climate and visibility, and their ability to form clouds. In the atmosphere, the water content of the particles depends on their composition as well as the relative humidity and temperature. As crystalline salt particles are exposed to increasing relative humidity, the deliquescence phase transition results in rapid formation of aqueous droplets at the deliquescence relative humidity (DRH). The DRH values of atmospheric salts are generally well predicted by theory. In contrast, decreasing relative humidity results in particle morphologies and water content that are difficult to predict theoretically, and must be measured in the laboratory. At sufficiently low relative humidity, the droplets may undergo efflorescence (at the ERH), resulting in recrystallization of the salt particles. Hysteresis in water uptake and loss is often observed and the DRH can be very much higher than the ERH. Thus atmospheric salt particles are often assumed to be aqueous throughout much of their atmospheric lifetime. Here we use a long working distance optical trap to measure the deliquescence and efflorescence phase transitions of individual levitated salt particles. In addition, we probe how efflorescence is influenced by collisions of the salt droplet with other particles and by immersion of solids within the droplet. We find that while both contact and immersion can promote efflorescence, contact-induced efflorescence is by far more effective. These laboratory experiments challenge our theoretical understanding of nucleation in microscopic salt particles. In addition, the experiments have implications for particle phase and water content of aerosols in the global atmosphere.