# NANO HIGHLIGHT
# Nanoscale Processes in the Environment: Atmospheric Nanoparticles

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Particles having diameters between 1 and 100 nanometers are ubiquitous in the air we breathe. These nano-size particles directly impact human health when inhaled. In addition, nano-size particles grow into the larger particles that strongly influence global climate, atmospheric chemistry, visibility, and regional and global transport of pollutants and biological nutrients.

A key property in any understanding of atmospheric particles is their interaction with water vapor. In particular, particles can exist in two physical states. At low relative humidity, they can be free of water and crystalline. At high relative humidity, water can condense on the particles and make aqueous solutions. These two physical states are similar to the processes affecting salt in the table salt shaker during periods of high relative humidity in the home.

The physical state of particles directly affects their diameter. Notably, water uptake leads to swelling of the particles. Because diameter affects transport and diffusion properties, a systems-level understanding of the fate and transport of nano-size particles is incomplete without being able to predict whether a particle is in its crystalline or aqueous physical state. A further intricacy is that, in the nano-size regime, phase depends in undetermined ways on particle diameter because of the important contribution of surface free energy and because of the slow nucleation rates and thus persistence of metastable phases. We have set up laboratory experiments to understand and quantify these nano-size effects.

Our results are shown in the figure on the right. Until relative humidity goes above 85%, the 7-nm particles do not change diameter. However, at 87% relative humidity, there is an abrupt increase to 12 nm. This abrupt change corresponds to the phase change from crystalline to aqueous particles. Importantly, this change occurs at a significantly higher relative humidity for nano-size particles than for larger particles. Namely, larger crystalline particles become aqueous at 75% relative humidity. Thus, the nano-size effect has shifted the humidity by 12% for 7-nm particles. The implications for systems-level descriptions of nanoparticle life cycles are significant because of the strong dependence of the component processes on particle diameter.