Geophysical Research Abstracts
Vol. 17, EGU2015-14778-1, 2015
EGU General Assembly 2015

Size dependence of phase transitions in aerosol nanoparticles

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Phase transitions of nanoparticles are of fundamental importance in atmospheric sciences. Current understanding is insufficient to explain observations at the nano-scale. In particular, discrepancies exist between observations and model predictions of deliquescence and efflorescence transitions and the hygroscopic growth of salt nanoparticles. Here we show that these discrepancies can be resolved by consideration of particle size effects with consistent thermodynamic data. We present a new method for the determination of water and solute activities and interfacial energies in highly supersaturated aqueous solution droplets. Our analysis reveals that particle size can strongly alter the characteristic concentration of phase separation in mixed systems, resembling the influence of temperature. Due to similar effects, atmospheric secondary organic aerosol particles at room temperature are expected to be always liquid at diameters below $\sim$20 nm. We thus propose and demonstrate that particle size should be included as an additional dimension in the equilibrium phase diagram of aerosol nanoparticles.

Reference:

Cheng, Y. et al. Size dependence of phase transitions in aerosol nanoparticles. Nature Communications. 5:5923 doi: 10.1038/ncomms6850 (2015).