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Direct comparative measurements of aerosol hygroscopicity

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The composition and size of inorganic/organic/aqueous aerosol particles in the atmosphere and partitioning between organic and aqueous phases are dependent on relative humidity (RH). Laboratory studies can provide a rigorous test of thermodynamic models that predict the equilibrium properties of mixed component aerosol such as the variation in wet particle size with RH and the characterisation of the mixing state of different aerosol components.

In this work, the thermodynamic behaviour of organic/inorganic/aqueous aerosol droplets is investigated by coupling optical tweezers with Raman spectroscopy. This allows direct comparative measurement of the evolving size, composition and phase of two droplets of differing composition within the same gas phase. Such studies can provide highly accurate measurements of RH when one of the droplets has well characterised hygroscopic properties, such as an aqueous sodium chloride droplet. Using this approach, the RH can be determined with an accuracy of 0.1 % and 1 s time-resolution even up to saturation in the immediate proximity of the second droplet. This approach can be used to examine the influence of water soluble, insoluble and immiscible organic components on aerosol hygroscopicity.

The influence of water-soluble organics on hygroscopicity was investigated by trapping a glutaric acid/inorganic/aqueous aerosol droplet and an inorganic/aqueous aerosol droplet simultaneously and monitoring their evolution in size and composition. The measured Köhler curve for the organic doped droplet showed excellent agreement with model predictions from ADDEM and a modified version of AIM. Finally, evolving hygroscopicity following oxidation of an aqueous/sodium chloride/oleic acid

droplet was investigated in a preliminary study into the aging of organic aerosols.