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Improving the Understanding of the Optical Properties of Atmospheric Aerosols

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The extent to which aerosols affect the Earth's radiative balance remains one of the largest uncertainties in modelling the climate.[1] It is critical to quantify the optical properties of aerosol particles to provide accurate parameterizations for radiative transfer models. A Bessel beam optical trap allows confinement of a single aerosol particle while it is probed with cavity ring down spectroscopy (CRDS) and the elastically scattered light is recorded. Fundamental properties such as radius, extinction cross-section, refractive index (RI) (at multiple wavelengths) and hygroscopic behaviour of single aerosol particles have been examined with this technique.

To date, a number of atmospherically relevant salt solutions (containing the solutes sodium chloride, ammonium sulfate, ammonium bisulfate or sodium sulfate) have been examined. Single salt droplets were trapped at high relative humidity (RH) and the evolving optical properties examined as the RH was lowered. At least 5 separate droplets for each solution have been measured. Analysis of the elastically scattered light, known as phase functions (PF) and CRDS provided the radius and RI of the droplet. Measurements have been combined to describe the average RI variation with RH retrieved from PF (473 nm) and CRDS (532 nm) analysis. These measurements provide RI to a high degree of precision. *Figure 1* shows the average RI of 5 ammonium bisulfate droplets, the mean standard deviation in RI ± 0.002 and ± 0.003 at 532 nm and 472 nm respectively, which corresponds to an uncertainty in radiative forcing of ~1%.[2]

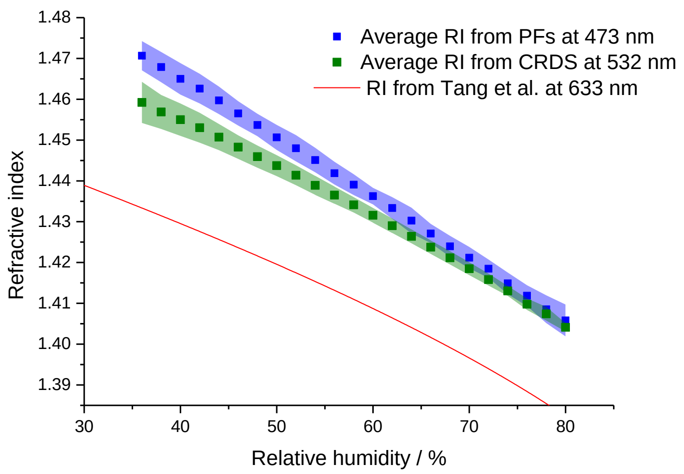

Figure 1: The average RI of 5 ammonium bisulfate droplets (indicated by the blue and green squares which correspond to 473 nm and 532 nm respectively), the shaded area corresponds to the standard deviation in RI, measurements at 633 nm by Tang et al.[3, 4] are shown in red.

Currently further measurements of atmospherically relevant salts droplets are being completed with CRDS at 405 nm. The amalgamation of all measurements at the different wavelengths (473 nm, 532 nm, 405 nm) will allow the calculation of chromatic dispersion through a range of RHs. Furthermore this technique will be used to study mixed component droplets in order to examine mixing rules.

References

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