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Optical properties of absorbing and non-absorbing aerosols retrieved by cavity ring down (CRD) spectroscopy

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The optical properties measurements of laboratory generated pure and mixed aerosols are presented here. The extinction coefficient (α_{ext}), extinction cross section (σ_{ext}) and extinction efficiency (Q_{ext}) for polystyrene spheres (PSS), ammonium sulphate ($(NH_4)_2(SO_4)$), sodium chloride (NaCl), glutaric acid (GA), and Rhodamine-590 aerosols were measured using cavity ring down (CRD) spectroscopy at 532 nm. In addition, the refractive indices of the different aerosols were retrieved by comparing the measured extinction efficiency as a function of size parameter (x) for each aerosol type to that predicted by Mie theory. The retrieved refractive indices of pure polystyrene spheres (PSS) and ammonium sulphate aerosols were in agreement with the values reported in the literature. Two different types of mixed aerosols were studied. First, aerosols composed a homogenous mixture of two non-absorbing compounds, sodium chloride and glutaric acid. Second, aerosols composed mixtures of absorbing and non-absorbing compounds, Rhodamine-590 dye (which absorbs strongly at 532 nm) and ammonium sulphate. The refractive indices of the mixed aerosols were also determined by comparing the experimental extinction efficiency to those predicted by Mie theory. In addition, the ability of different optical mixing rules to predict the refractive index of the aerosols was tested. We found that for non-absorbing mixtures, the linear rule, Maxwell-Garnett rule, extended effective medium approximation (EEMA), and core plus shell model result in merit functions of the same order, with the linear mixing rule giving a slightly better fit overall than the others. The mixing rules/models produce refractive indices similar to those retrieved from the measurements, but the fit to the measurements is worse than those of the single component aerosol refractive

index retrievals. For absorbing mixtures, the differences between the refractive indices calculated using the mixing rules and those retrieved by CRD are generally higher. For higher volume fractions of the absorbing substance, the EEMA gives the best result, while for the lowest volume fraction studied, the core plus shell model gives the best result (and the rest of the mixing rules give results that are not far off).