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Hygroscopicity of organic surrogate compounds from biomass burning and their effect on the efflorescence of ammonium sulfate in mixed aerosol particles

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A number of field-based hygroscopicity studies about biomass burning aerosol focus on the growth factors of mixtures at high RH (e.g. 90 % RH) using a hygroscopicity tandem differential mobility analyzer (HTDMA). However, less attention has been paid to the growth behavior at low to moderate RH, limiting the database for accurate estimates of particles optical and radiative properties over those lower RH ranges. However, this is a RH range in which water uptake or release behavior demonstrates a considerable variability among different organic-inorganic systems. The occurrence or suppression of a liquid-solid phase transition affects the physicochemical particle properties in a relative narrow RH range, potentially leading to particles of different morphology and physical states, affecting effective particle size and density. In this work, measurements and thermodynamic equilibrium predictions for organic-inorganic aerosols related to components from biomass burning emissions demonstrate a diversity of hygroscopic growth/shrinking behavior. For example, in the case of aerosol mixtures containing levoglucosan and ammonium sulfate, the presence of levoglucosan may cause the efflorescence of AS to occur at higher RH than in pure aqueous AS particles-or it may completely suppress AS efflorescence, as observed for mixtures with a high levoglucosan mass fraction. The growth curves predicted with the Aerosol Inorganic-Organic Mixtures Functional croups Activity Coefficients (AIOMFAC) and the Extended Aerosol Inorganic Model (E-AIM) thermodynamic equilibrium models reproduce the observations in most cases reasonably well and we demonstrate the usefulness of AIOMFAC-based predictions with different assumptions about the physical state of the organic components for the interpretation of experimental data (two phase-transition of mixtures), such as in the case of mixtures of 4-hydroxybenzoic acid and ammonium sulfate. In addition, the small difference of hygroscopicity parameters of mix-bio-dry and mix-bio-wet systems between measured data in the laboratory using HTDMA and the field using CCN activity measurements is due to the similar O:C ratios of organic surrogate compounds and ammonium sulfate mass fractions used in the model mixtures when experimental [U+0138] data from sub- and super-saturated water vapor conditions are compared.