Geophysical Research Abstracts
Vol. 15, EGU2013-5875, 2013
EGU General Assembly 2013

Morphologies of aerosol particles consisting of two liquid phases

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Recent studies have shown that liquid-liquid phase separation (LLPS) might be a common feature in mixed organic/ammonium sulfate (AS)/H_2O particles. Song et al. (2012) observed that in atmospheric relevant organic/AS/H_2O mixtures LLPS always occurred for organic aerosol compositions with O:C < 0.56, depended on the specific functional groups of organics in the range of 0.56 < O:C < 0.80 and never appeared for O:C > 0.80. The composition of the organic fraction and the mixing state of aerosol particles may influence deliquescence relative humidity (DRH) and efflorescence relative humidity (ERH) of inorganic salts during RH cycles and also aerosol morphology.
In order to determine how the deliquescence and efflorescence of AS in mixed organic/AS/H_2O particles is influenced by LLPS and to identify the corresponding morphologies of the particles, we subjected organic/AS/H_2O particles deposited on a hydrophobically coated substrate to RH cycles and observed the phase transitions using optical microscopy and Raman spectroscopy.
In this study, we report results from 21 organic/AS/H_2O systems with O:C ranging from 0.55 – 0.85 covering aliphatic and aromatic oxidized compounds. Eight systems did not show LLPS for all investigated organic-to-inorganic ratios, nine showed core-shell morphology when present in a two-liquid-phases state and four showed both, core-shell or partially engulfed configurations depending on the organic-to-inorganic ratio. While AS in aerosol particles with complete LLPS showed almost constant values of ERH = 44 $\pm$ 4 % and DRH = 77 $\pm$ 2 %, a strong reduction or complete inhibition of efflorescence occurred for mixtures that did not exhibit LLPS. To confirm these findings, we performed supplementary experiments on levitated particles in an electrodynamic balance and compared surface and interfacial tensions of the investigated mixtures.

Reference

Song, M., C. Marcolli, U. K. Krieger, A. Zuend, and T. Peter (2012), Liquid-liquid phase separation in aerosol particles: Dependence on O:C, organic functionalities, and compositional complexity, Geophys. Res. Lett., 39doi:10.1029/2012GL052807.