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Prompt deliquescence and efflorescence of aerosol nanoparticles

G. Biskos¹, D. Paulsen¹, L. M. Russell², P. R. Buseck³, and S. T. Martin¹¹Division of Engineering and Applied Sciences, Harvard University, Cambridge, MA 02138, USA²Scripps Institution of Oceanography, University of California San Diego, La Jolla, CA 92093, USA³Departments of Geological Sciences and Chemistry/Biochemistry, Arizona State University, Tempe, AZ 85287, USA

Abstract. Literature reports have differed on the possibilities of discontinuous and continuous (i.e., prompt and nonprompt) deliquescence and efflorescence of aerosol particles in the nanosize regime. Experiments reported herein using a hygroscopic tandem nano-differential mobility analyzer demonstrate prompt deliquescence and efflorescence of ammonium sulfate particles having diameters from 6 to 60 nm. Apparent nonpromptness can be induced both by operation of the experimental apparatus and by interpretation of the measurements, even though the underlying phase transitions of individual particles remain prompt. No nanosize effect on the relative humidity values of deliquescence or efflorescence is observed for the studied size range. Smaller hygroscopic growth factors are, however, observed for the nanoparticles, in agreement with thermodynamic calculations that include the Kelvin effect. A slightly nonspherical shape for dry ammonium sulfate particles is inferred from their hygroscopically induced reconstruction between 5 and 30% relative humidity. Our results provide a further understanding of nanoparticle behavior, especially relevant to the growth rates of atmospheric nanoparticles.

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