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Interactive Comment

Interactive comment on “Hygroscopic properties of NaCl and NaNO₃ mixture particles as reacted inorganic sea-salt aerosol surrogates” *by* D. Gupta et al.

Anonymous Referee #1

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Title: Hygroscopic properties of NaCl and NaNO3 mixture particles as reacted inorganic sea-salt aerosol surrogates

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This work reports a systematic and rigorous experimental study about hygroscopic behavior of individual particles with sizes < 10μm of a common but important atmospheric system i.e NaCl/NaNO3. Optical microscopy was used to investigate deliquescent and efflorescence of individual particles impacted on hydrophobic substrate for various mix-

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ing ratio of NaCl and NaNO3. The change in particle size with the variation of humidity is monitored by measuring the particle areas in the optical images, complementary SEM/EDX measurements were carried out on dried particles to assess the mixing state of individual particles. The experimental results presented by Authors are supported by a well-used thermodynamic model (i.e. AIOMFAC). The introduction is well documented and clearly points out the main difficulties for studying hygroscopicity properties of individual particles. The methodology used here was previously published by Authors (Ahn et al., 2010 and Eom et al., 2014) and has demonstrated its feasibility for investigating hygroscopic behavior of individual particles. Thus, citation of these articles in the experimental section is lacking. The results provided by Authors allow building complete DRH and ERH phase diagrams for individual particles with micrometer sizes with mole fraction of NaCl varying from 0.1 to 0.9. Authors clearly demonstrated the hygroscopic behavior as function of the particle composition (i.e. XNaCl = 0.38 (eutonic composition), XNaCl > 0.38 and XNaCl < 0.38) and explain in a very didactic manner the efflorescence and deliquescent behavior of particles step by step during the humidification and dehydration process. Authors evidenced two-stage phase transitions during humidifying process except for the eutonic composition. This is in good agreement with the thermodynamic modeling. The dehydration behavior of particles was also explained by the mixing ratios of the two salts. Interestingly, eutonic composed particles and particles with XNaCl > 0.38 showed two-stage efflorescence transitions while NaNO3 -rich particles showed only a single transition. The microstructure of the dried particles was investigated. SEM/EDX evidenced the core-shell structure of the dried particles which is composed of NaCl in the center and eutonic composed solid shell whatever the initial composition of the particle. Finally, the results are discussed in regards to the atmospheric implication. To our knowledge this is a huge insight in the comprehension of the hygroscopic behavior of individual particles. Actually, this work provides a complete description of the behavior of the particles including particle microstructure during humidifying and dehydration processes. I strongly recommend the publication of the work as is in ACP. However, I have two minor questions: 1- The

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change in particle size with the variation of RH is based on optical image analyses meaning that 2D projected areas are taken into account. Since some of particles are not perfectly rounds after crystallization (as seen on SEIs images figure 5), what is the diameter taken into account? feret's diameter? 2- On figure 2.a we can see that A/A0 of NaNO3-rich particles after efflorescence is larger than 1. This means that the particle size is larger than the initial one at the final step of the process. We cannot observe this behavior for the other mole fractions. Moreover the microstructure of individual particles showed on the figure 5 does not seem to exhibit some differences with NaCl-rich particles. Do the authors have any explanation for this size variation?

Interactive comment on Atmos. Chem. Phys. Discuss., 14, 33143, 2014.

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