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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Ternary solution of sodium chloride, succinic acid and water – surface tension and its influence on cloud droplet activation" *by* J. Vanhanen et al.

Anonymous Referee #2

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This paper presents surface tension measurements of a ternary solution of water, succinic acid, and sodium chloride, which are parameterized and extrapolated to supersaturated conditions relevant to atmospheric aerosols. The resulting surface tension model is then integrated into a cloud model to demonstrate the effect of surface-active aerosol organics on CCN activation. This is an interesting approach and more studies of this type directly connecting laboratory results to their impact on model outputs are needed. However, I have some concerns, which are outlined below.

- The language of the abstract should be refined in order to emphasize the novel contributions of this work. Also, it should be made clear in the abstract that the param-

eterization was extrapolated from concentration range of the experimental data; "An equation based on thermodynamical relations was fitted to the data" is understated to the point of being misleading. This is described quite clearly and satisfactorily in the first paragraph of the conclusion, perhaps try to emulate that in the abstract.

- Introduction, paragraph 2: since the authors are focusing on NaCl as a sea-salt proxy they should mention the incorporation of organics at the sea-surface when sea salt aerosols form via bubble bursting (Gershey, 1983). The authors should also provide citations of field observations of succinic acid in marine aerosol.

- Section 2.3: While the density estimation in equations 2-3 is an elegant approach, measuring the density of a liquid is a simple matter, so it's not clear why the theory is necessary. The authors should at least "spot check" the theory results with a few direct measurements of the density of their ternary solutions at different concentrations to show consistency.

- Section 3.1.2: "Surface tension of the solution decreased with increasing temperature as expected." This statement should be supported with a reference.

- Section 3.1.2: Please provide more discussion regarding the differences in these results vs. the observations of Tuckerman (2007) and Kiss (2005)

- The authors should provide an estimate of the uncertainty of the data in Table 2 based on propagation of the measurement uncertainty, and its impact on the parameterization.

- Extrapolating surface tension measurements in this system out of the range of concentrations measured is problematic. For one, the authors assume that the aqueous phase of the aerosol will become supersaturated in both succinic acid and sodium chloride. However, as the aerosol becomes supersaturated in NaCl, the succinic acid may be "salted-out" of solution and crystallize(Setschenow, 1889). This should be commented upon directly in the text.

ACPD
8, S1698–S1701, 2008

An additional important point for discussion is that the authors neglect the formation of micelles or other phases as particle composition & temperature changes, while these phenomena can change surface tension and water uptake (Cistola et al., 1988;Tabazadeh, 2005). The authors make this omission clear in the text, but given the potential significance of these phenomena to CCN activation, they should provide a justification based on published values of the critical micelle concentration, etc. for why this is an acceptable assumption. The authors' characterization of these processes as "macroscopic phenomena" and continuing on to say "despite these uncertainties, the extended parameterization is applicable in models simulating microscopic phenomena such as nucleation" misses the point.

The authors should also provide an explanation, if there is any, for why it makes physical sense to extrapolate from the surface tension of an ordered surface film of succinic acid on an aqueous substrate to that of a supercooled succinic acid liquid, and likewise from an aqueous NaCl solution to a molten NaCl salt.

- Conclusion, final paragraph, first sentence: "relevance" should be replaced by "impact" or similar.

- Overall, the paper needs to be edited carefully for English language. Many misunderstandings may arise from language errors in this manuscript: for example, the first complete sentence after equation 7 reads "Few assumptions had to be made in order to obtain a fit that represents surface tension of the ternary solution beyond the solubility limits (Table 1)" Whereas surely the authors meant "A few assumptions" and in fact it would be more accurate to say "Several assumptions"

REFERENCES

Cistola, D. P., J. A. Hamilton, D. Jackson and D. M. Small, Ionization and Phase-Behavior of Fatty-Acids in Water - Application of the Gibbs Phase Rule, Biochemistry, 27(6), 1881-1888, 1988.

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8, S1698–S1701, 2008

Gershey, R. M., Characterization of Seawater Organic-Matter Carried by Bubble-Generated Aerosols, Limnology and Oceanography, 28(2), 309-319, 1983.

Setschenow, J. Z., Uber Die Konstitution Der Salzosungenauf Grund auf Ihres Verhaltens Zu Kohlensaure, Z. Physik. Chem., 4, 117-125, 1889.

Tabazadeh, A., Organic aggregate formation in aerosols and its impact on the physico-chemical properties of atmospheric particles, Atmospheric Environment, 39(30), 5472-5480, 2005.

Interactive comment on Atmos. Chem. Phys. Discuss., 8, 7189, 2008.