

# ***Interactive comment on “A thermodynamic description for the hygroscopic growth of atmospheric aerosol particles” by Dimitri Castarède and Erik S. Thomson***

## **Anonymous Referee #2**

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Castarede and Thomson present a theoretical approach to modeling pre-deliqescence condensation of water onto soluble salt particles and particle growth using a “refined Kohler theory”. There are implications here for understanding and modeling mixed phase clouds and aqueous chemistry. The authors’ theoretical treatment is quite elegant and the manuscript is well written. I am in favor of publication but recommend the authors address the comments below.

### Specific comments:

- As the authors note, several other works have been published that also present a theoretical treatment of pre-deliqescence (notably, Bruzewicz et al. 2011). I encour-

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age the authors to more clearly state where their approach differs from others, and the advantages of using the refined Kohler model presented here over that of Bruzewicz et al.

- The inflection in some of the curves in Figure 4 warrants more explicit discussion because this behavior is not physically realistic and represents a limitation of the model. For example, in Fig. 4A, for the purple line, there are two GF values that correspond to 80% RH (at  $GF \sim 1.05$  and  $GF \sim 1.3$ , the inflection point being  $\sim 85\%$  RH). I was ultimately able to piece together where the inflection arises, but I encourage the authors to more explicitly discuss the trends shown in Figure 4 and their origins. Specifically, for example, I was looking for a sentence or paragraph in the discussion that explicitly stated “The inflection seen in Fig. 4 for small particles is due to...”.

- As is well-known, atmospheric aerosols are not single component and are mixed with organic compounds. The authors mention that “natural systems may require more complex treatments...” (p. 6, line 5) and also that the refined Kohler theory “remains general such that its application to more complex systems may yield deeper understandings of aerosol phase state and particle behavior” (p. 7, line 12), but there is not discussion of steps that may need to be taken to apply the refined Kohler theory to mixed organic/inorganic systems. I encourage more discussion here, as it would facilitate the application of their refinement.

- Have the authors attempted to apply their refined Kohler theory to a system other than NaCl?

- Much of the discussion and implications of the research are mentioned for the first time in the “Conclusions” section. This discussion would be better served in its own section. For example, the discussion surrounding Figure 6, which is currently called out for the first time in the conclusions, would be appropriate in a new section for “Discussion” or “Implications”. This would enhance readability.

Technical comments - The y-axis values in the inset to Figure 3 have commas rather

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than periods for the decimal point.

- I believe that on p. 1, line 14, the reference Davis et al. 2015b should be labeled as “a” (and Davis et al. 2015a should then be labeled “b”).

- On p. 4, line 5, Van’t Hoff and E-AIM models are mentioned without references. References should be provided.

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