

## ***Interactive comment on* “Plume-exit modeling to determine cloud condensation nuclei activity of aerosols from residential biofuel combustion” by Francisco Mena et al.**

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This paper presents a pretty straightforward set of “Toy model” simulations of near emission aerosol thermodynamics spun towards the question of what happens to bio-fuel particles in the seconds after it leave the stack and what this potentially means for CCN activity. They provide a series of conclusions that really boil down to that condensation of semi-volatiles trumps coagulation in changing particle size which then leads to increased CCN efficiency. They use a fairly set of good modeling tools, but in a box model format where dilution and SVOC properties are explicit. They also use some extreme values of inorganic mass fractions taken from the FLAME studies to see how varying core particle hygroscopicity may change things. They also spend some time

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describing results on Aiken mode particles which can be high in number but due to their size generally have low CCN efficiency unless they are highly hygroscopic.

I think for what the paper is, it is well done and generally well written. I do however have some questions of representativeness that I think can be easily fixed in the introduction and conclusions. First, the conclusions are really not that surprising and can be inferred from other studies over the past 30 years. Vanderlei Martins and I both did back of the envelope calculations >25 years ago in our papers and dissertations noting that condensation was the big dog in evolving plumes. The current paper does a nice job formalizing this in particular for near field biofuel emissions, but even here simultaneous coagulations and condensation has been studied for a very long time. I went to web of science and typed various combinations of such key words as aerosol dynamics, combustion, flue, condensation and coagulation and found a number of useful papers. This is all done for the power industry, which I guess biofuel is. Not exactly exhaust fuel for biofuel and the implications for CCN, but the key aerosol dynamics are in there and even some lab-model intercomparisons. Thus, I think a little perspective warranted on how this work bridges these fundamental thermodynamic studies with emissions to the atmosphere. The paper is somewhat unique on the CCN angle, but again some perspective is required. Even though particle microphysics and chemistry largely freezes after 5 seconds, the CCN properties of the particles will likely evolve further in the atmosphere when they mix and react with everything else. This has been a common criticism of mine of studies like the FLAME series. I think they are great for insight, but cannot be taken and directly applied to ambient aerosol populations. So what do the authors think the bottom line ramifications of their results are? Seems like we better sort out what is going on in the SVOC. It might help if this paper is torqued to frame such conclusions as priorities for studies.

Even though the thermodynamics presented here is for the immediate emissions of biofuels it might be worth joining this with the bigger picture. For example, even though these are small plumes, it might be worth the author's time to quickly go through Kip

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Carrico's recent paper on near field plume behavior. I think there is some overlap in results, particularly on the laboratory side. Carrico, C. M., A. J. Prenni, S. M. Kreidenweis, E. J. T. Levin, C. S. McCluskey, P. J. DeMott, G. R. McMeeking, S. Nakao, C. Stockwell, and R. J. Yokelson (2016), Rapidly evolving ultrafine and fine mode biomass smoke physical properties: Comparing laboratory and field results, *J. Geophys. Res. Atmos.*, 121, 5750–5768, doi:10.1002/2015JD024389. Or even go back to Vanderlei and my original work. Further back is all of the good work done by Turko.

One other minor thing, Page 7, line 10: Table 1 says “organic carbon” but I think you want to say particulate organic matter. Thus throughout the paper, there is some confusion as to what is OC and what is POM. This makes a pretty big difference in interpretation.

Hope this helps, Jeffrey S. Reid US Naval Research Laboratory

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