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Comment on acp-2022-349

Anonymous Referee #1

Referee comment on "Aerosol size distribution changes in FIREX-AQ biomass burning plumes: the impact of plume concentration on coagulation and OA condensation/evaporation" by Nicole A. June et al., Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2022-349-RC1, 2022

Major comments

Key factor controlling aerosol size distribution in biomass burning plumes is interesting and important topic in current air quality and climate change studies. This work analyzed the impact of plume concentration on coagulation and OA condensation/evaporation based on FIREX-AQ aircraft measurements. They found the median particle diameter increases faster in smoke of a higher initial OA concentration than smoke of a lower initial OA concentration. Their box model simulation suggested that coagulation explains the majority of the diameter growth and OA evaporation/condensation having a relatively minor impact on the diameter growth. Although the authors provided systemic analysis with FIREX-AQ measurements, the results found by them are not novelty. Similar results have been reported by previous studies. The authors need to highlight their new findings in this work.

For the writing style of this manuscript, too much Figures were put in supporting material with unnecessary. It broke the logical flow of the paper.

There are some scientific questions need to be addressed.

- Most of the authors' analysis is based on smoke age. However, the definition of smoke age in this work is too simple and seems not to reflect the impact of turbulence and wind shifting. However, the uncertainties of smoke age could impact significantly on the authors' analysis, discussions, and conclusions.

- One of the major conclusions is the authors found OA evaporation/condensation having a relatively minor impact on the diameter growth. However, this conclusion is based on box model simulation. As shown in the simulations presented in the paper, OA condensation in young age plume and OA evaporation in old age plume seem not to be reflected by the box model.

- The authors used linear regression to fit the dependence of median diameter with smoke age. Median diameter cannot increase without limitation. I do not think linear regression is suitable to be used here.

Minor comments

Line29: μg m-3. -3 needs to be superscript. Please check the unit in the paper.

Line200: Change x to multiple sign.

Line239-240: How do the authors think about the impact of wind direction/shifting on

their method to calculate the smoke age? Wind direction may not always follow the straight-line between the fire and aircraft position.

Page8Equation2: It is unclear what do inplume and background refer to. Does inplume refer to the value sampled at aircraft position in plume? Where are the background values sampled?

Line304: More details about the assumptions, settings, and initial conditions to run the coagulation model are needed. Based on current information, it is hard to reproduce the results presented in this work.

Line339-341: I agree with the authors' discussion that the diameter growth rates should be slowed with the smoke age. However, according to Fig.2, we did not see such slowdown. The authors need to explain this disagreement.

Line455: Why does median diameter drop after 5h in Fig.7b? Why is median diameter low during 0.5-1.5h and then rapid increased after 1.5h in Fig.7c?

Line475-477: Need to explain the reason why the change from non-size-dependent evaporation to size-dependent evaporation in model is small.

Line478: Can it be caused by the treatment of dilution in the box model?

Line489-490: Why does the impact of changing emission on number concentration is larger than size distribution?

Line491-492: In Fig.7b and Fig.7g, the consideration of OA evaporation/condensation reduced the agreement of simulation and observation. More discussions on this are needed. Usually, young age plume is dominated by OA condensation, while old age plume is dominated by OA evaporation. I did not see this reflected in these simulations. Do the authors know why the simulation works this way?

Page28Fig1: Map shown here is helpless to readers who are not familiar with local geography of Idaho. Map with land use type is more useful.