Responses to Reviewers for: ***Developing A Custom-Built Metal Aerosol Processing Chamber: Analysis of Aerosol Coagulation at Low Humidities.***

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Responses to the reviewers are shown in blue. **Additions to the main text are bold.**

Reviewer 3

Franco et al., describes a new design of "Cloud chamber" and gives a characterization of dry particle experiments using sodium chloride, sucrose and soot particles. In these experiments, the wall loss rate, particle coagulation rate and dilution rate are estimated under dry conditions. Results show similar wall loss rate and different coagulation behaviors among these aerosols.

In this article, several key information on the aerosol generation, chamber characterization and result illustrations are missing. It is suggested to reject and resubmit the article after completing these informations.

Major comments:

1/ It is believed that authors would like to build a "Cloud chamber" in order to study physical and/or chemical processes during the cloud process and this is the first publication on this new design. However, the characterization of this new stainless-steel chamber is not complete, such as Surface/Volume ratio, working pressure, mixing ratio, gas monitoring (VOC from the combustion), etc.

Response: We have added some of the requested parameters (Surface/Volume ratio, working pressure) however, we disagree that concentrations of gases are important for chamber characterization in the current experimental design. Concentrations of gases could be measured in the future, and will be, for specific experiments designed to look at gas-aerosol interactions in the chamber.

2/ The research on the literature is not fully enough.

2.1/ Authors made a short introduction on the Cloud chamber. It is well known that RH is one of the most important parameters that impacts on the wall loss ratio and particle coagulation in the cloud chamber (Doussin et al., 2023). It is not clear why authors specifically made the study under dry conditions and would like to make a cloud chamber in the future.

Response: As we have modified the title and goals of the paper due to comments from other reviews by changing from cloud chamber to aerosol processing chamber, now humidity is not a specific target. As for Doussin et al., they suggest wall-loss experiments at low and higher humidity ranges, but do not offer a physics-based correction for high humidity conditions. Thus, keeping with low humidity conditions for this manuscript, seems sufficient.

2.2/ Authors highlighted in this work one critical aerosol: soot. Apparently, the characterization of soot is missing. Soot is generally fractal-like and highly dependent on the combustion conditions. The aggregation of soot particles is one of the most important parameters that impacts the mobility diameter measured by the SMPS, i.e., for a single freshly emitted soot particle, the different aggregation due to the aging processes (lifetime, RH, VOCs and chemical processes) brings different mobility diameters (Peng et al., 2017).

Response:
We appreciate the reviewer's point and fully agree that soot morphology (fractal dimension, aggregation state, aging) influences mobility diameter. However, as reviewer 1 pointed out, our study used biomass-burning aerosol smoke which is a complex mixture, that includes but is not limited to soot/black carbon, rather than on pure, well-characterized soot standards (e.g., diesel or propane flame soot). The objective of this project was to quantify size-dependent wall-losses and coagulation behavior in our chamber using realistic smoke, NaCl and sucrose particles, not to perform a full morphological characterization of soot aggregates vs time.

Comprehensive determination of soot fractal properties (e.g., via SEM/TEM image analysis or SP2-based methods proxies) was beyond the scope and timeline of this project.

We now clarify in the manuscript that our particles originated from biomass burning smoke, and they are a combination of soot, organics and inorganics. We changed the language throughout using smoke instead of soot. We also added more to the discussion that soot is just one part of the smoke from biomass burning smoke.

Text Updated: To generate smoke, 0.1 – 0.5 g samples of dried biomaterial *Poa pratensis* (Kentucky bluegrass) were weighed out, placed on a quartz boat and into a quartz-tube furnace (Carbolite Gero, TS1-1200, Verder Scientific, UK) that was set to 1000°C for a flaming combustion condition**. This identical setup was used in Benedict et al. (2024) which showed that at 1000°C burn the black carbon mass fraction averaged 17% for biomass fuels with a single scattering albedo of 0.35 (at 523 nm). We expect a similar smoke profile for the experiments presented here thus the smoke injected is a combination of soot, inorganic, and organic mass along with volatile vapors.**

Text updated: Early-time coagulation factors for smoke were moderately elevated, suggesting that **soot-fractal aggregates within smoke** can promote sticking or increased collisional radius.

3/ Lack of results. Even the size distribution is shown in figure 3, but the total number concentration of each experiment is never presented in the article. Authors fitted observed rates to theoretical rates (line 139). However, no results are shown how difference between the fitting and experimental results.

Response: We have added examples of number concentrations and distribution fitting to the supplementary material.

Added Supplemental Information:

2.3 Example Distribution fits.

Examples of smoke, sucrose, and NaCl experiments of a distribution fit at the 2 hour experiment mark, accompanied by the Pearson R-squared fit.

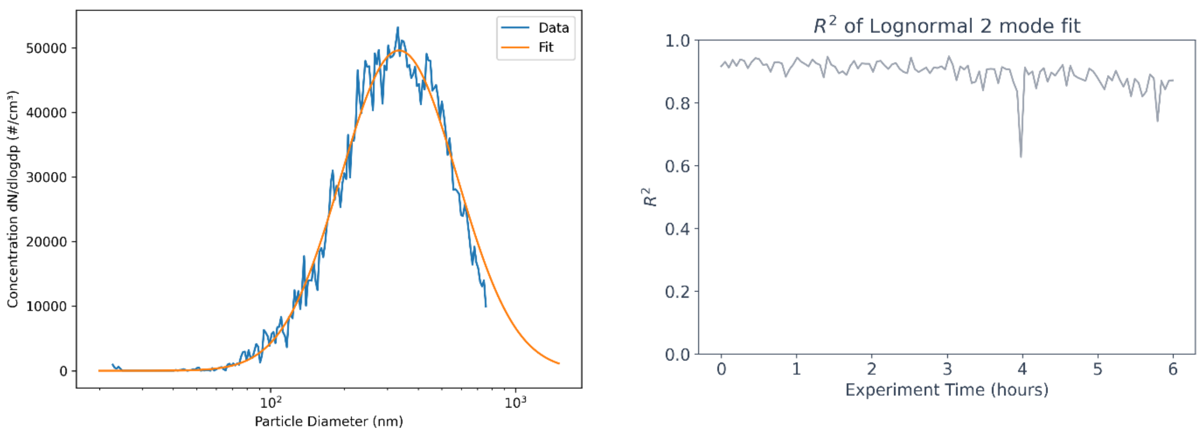

Figure S5: NaCl experiment. Left: fitted and measured size distribution. Right: Pearson R-squared of fit.

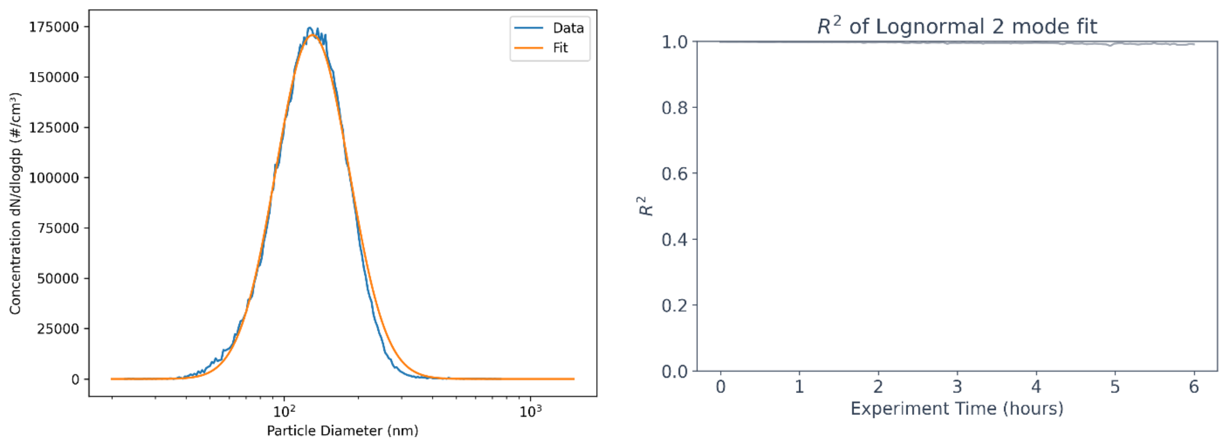

Figure S6: Smoke experiment. Left: fitted and measured size distribution. Right: Pearson R-squared of fit.

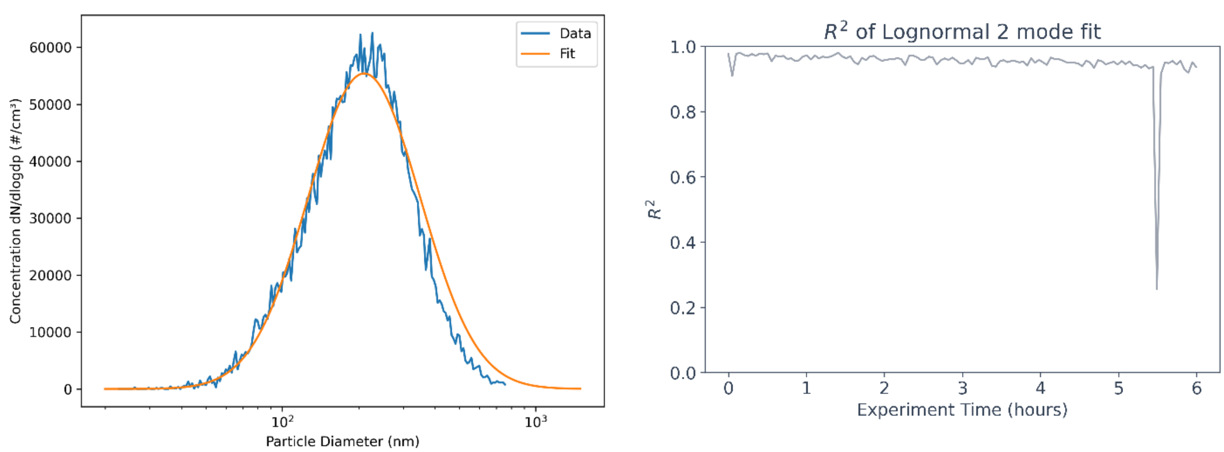

Figure S7: Sucrose experiment. Left: fitted and measured size distribution. Right: Pearson R-squared of fit.

2.5 Example Number Concentrations

Figure S9 shows the evolution of the typical total particle number concentration during the different species studies. The smoke injection produced the highest initial loading (>10^6 cm^{-3}) and maintained concentrations above 10^5 cm^{-3} for more than an hour (solid line). The NaCl was consistently the next highest, which was followed by sucrose. All experiments were conducted under identical chamber conditions (25 °C, <10 % RH, well-mixed).

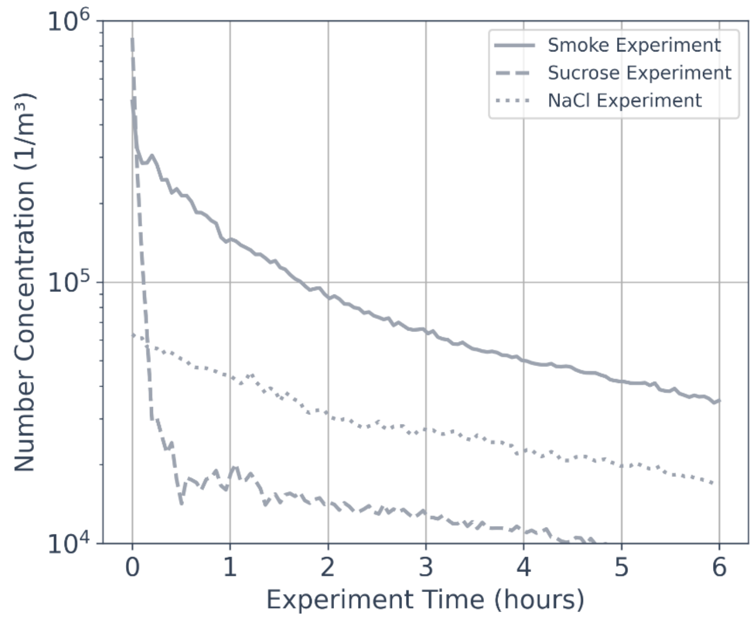

Figure S9: Evolution of the typical total particle number concentration during the three chamber experiment series.

References

Doussin, J.-F., Fuchs, H., Kiendler-Scharr, A., Seakins, P., & Wenger, J. (Eds.). (2023). A Practical Guide to Atmospheric Simulation Chambers. Springer Nature. https://doi.org/10.1007/978-3-031-22277-1

Peng, J., Hu, M., Guo, S., Du, Z., Shang, D., Zheng, J., Zheng, J., Zeng, L., Shao, M., Wu, Y., Collins, D., & Zhang, R. (2017). Ageing and hygroscopicity variation of black carbon particles in Beijing measured by a quasi-atmospheric aerosol evolution study (QUALITY) chamber. Atmospheric Chemistry and Physics, 17(17), 10333–10348. https://doi.org/10.5194/acp-17-10333-2017