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 1 -

Franco et al. designed and developed a cloud chamber at LANL and characterized the wall loss and coagulation correction factors of sodium chloride, sucrose, and soot. Their results show similar wall loss across all particle types, while the coagulation correction factor of soot is higher than others. This manuscript is overall well written and provides many useful information for chamber design, making it good fit for AMT journal. However, before the publication, I would like the authors to address the following issues.

We would like to thank reviewer one for their helpful comments. The reviewer highlighted several points that needed additional details and explanation in the main text. We have made these changes and improved the manuscript as a result.

1. For soot experiments, the authors generated them from biomass combustion, which produces complex emissions of both gas and particles. How do the authors ensure that only soot particles were injected into the LANL chamber? For example, biomass combustion emits abundant SOA, how might these SOA contribute to or interfere with soot growth in the chamber? Additionally, VOCs and SVOCs can also play a role in particle growth, thus change particle size. How do authors account for the influence of these gas species on the observed soot behavior in the authors' soot experiments?

Response: We have changed the phrasing to smoke (or biomass burning aerosol/BB aerosol), as we are in the soot regime but do not select for soot. We added additional discussion in section 2.2 on this burning setup from our previous publication (updated text below).

As for the proof of no condensation for VOCs, we cannot prove that directly. In previous work we have burned at a lower temperature (400 C) to shift the smoke to be dominated by organics and shown this with optical and black carbon measurements. In a smaller 34 L mixing tank we could see nucleation, likely from the VOCs. In this larger Aerosol Processing chamber no nucleation was observed at these low temperature burns. This is likely due to the dilution of smoke, we inject 20 L of smoke into 906 L of clean air. The aerosol processing chamber also has no active lighting for secondary aerosol formation, so photochemistry is unlikely to occur. We added additional text on this previous burn analysis and a section on volume conservation analysis.

Text updated and additions to manuscript: "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. Smoke particles were pushed to the chamber by zero-air at 4 L/min for 5 minutes, a time window used to ensure complete combustion of the sample.

Section added: **3.1 Volume Conservation Analysis**

If the corrected aerosol volumes remain consistent, within the noise measurement, we can infer that the processes described in Equation 1 accurately represent chamber behavior. Measured volume concentrations in our experiments were corrected by accounting for volume losses due to both wall-loss and chamber flow. We calculated the cumulative lost volume and added it back to the measured values at each time point.

In chamber experiments involving secondary organic aerosol formation, this volume conservation analysis provides a constraint on organic aerosol yields. Supplemental Figure S8 shows an example of our volume conservation plot from a smoke injection experiment. From this analysis, we conclude that volume is conserved and that no measurable condensation of biomass burning organic vapors occurs under our experimental conditions.

2. The manuscript presents particle number size distributions, but volume distributions are not discussed. Could the authors provide and discuss volume distribution? For example, have the dilution and wall loss corrections been validated using measured volume distributions, by quantifying the volume fraction of particles lost due to these processes?

Response: We have added the volume conservation analysis text to the manuscript (see response above). We added a graph to the supplemental information for an example volume conservation analysis.

Text added to supplemental information:

2.4 Example Volume Analysis

Figure S8 shows the time series of aerosol volume concentration for a representative chamber run of smoke, illustrating the effect of successive loss corrections. The raw measurement (grey) steadily declines because particles are removed by deposition to the walls and by the continuous push flow that maintains a slight over-pressure in the chamber. Correcting only for wall-losses (red) recovers part of the deficit, while correcting only for the push-flow dilution (gold) yields a different partial restoration. When both terms are applied simultaneously (black) the resulting curve is nearly level after the initial mixing period, indicating that the total suspended particle volume is conserved within the combined measurement uncertainty. The sharp spikes at 3 h and 5.7 h correspond to poor size distribution fits which get excluded in the final analysis. This volume conservation is confirming that no systematic bias is introduced by the procedure.

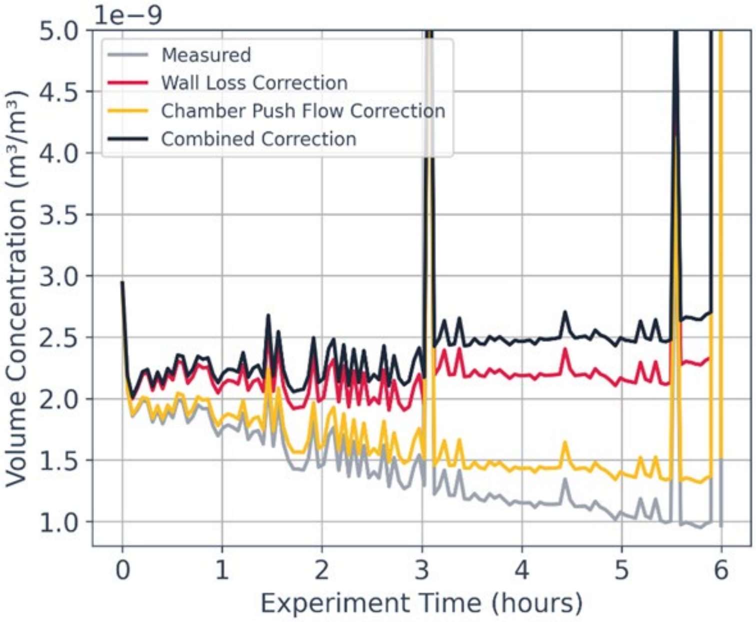

Figure S8: Volume conservation analysis for a smoke experiment.

3. Since no size selection was applied before aerosol injected into the chamber, how do the authors expect larger particles (e.g. PM>1) to influence coagulation and wall-loss behavior of submicron particles? Also, would it be possible for the authors to size-select particles to a specific mode prior to chamber injections to compare the size mode at the chamber outlet? Such an approach could help elucidate the role of coagulation in shifting size distributions.

Response: We agree that would be a good setup to clearly observe the role of coagulation. However, we did not have enough equipment to either size select or measure the size distribution at both the time of aerosol injection and at the chamber outlet.

The larger PM>1 particles could impact coagulation through sedimentation. In our experiments the higher bins (>600 nm) in the SMPS had a consistent log-normal tail. So, when we extrapolated the size distribution fit. Changing the extrapolation from 1 micron to 4 microns did not change the results noticeably. We used 4 microns, as that provides a consistent analysis method when doing dry and wet experiments.

We also added an additional bi-modal error analysis (see reviewer 2 responses) and saw that such an experiment would only have a modest reduction in the uncertainty.