Response to Reviewer 2

(comments in red, responses in black)

Dear Reviewer,

We thank the Reviewer for the careful assessment of our manuscript and for the constructive suggestions. We appreciate the positive evaluation of the cloud-chamber facility and its potential value for laboratory cloud-physics studies.

In response to the comments from both reviewers, the manuscript has undergone substantial revision and has been reframed from a quantitative seeding-effect study to a cloud-chamber design and characterization study. The revised manuscript is entitled "Design and Characterization of a Cloud Chamber for Warm- and Cold-Cloud Microphysical Studies." Unsupported quantitative seeding-effect, AgI-induced glaciation, and supersaturation interpretations have been removed or revised according to the available evidence. The responses to the individual comments are provided below.

Comment 1

Although the authors introduce a dual-tank cloud chamber designed to improve pressure control during expansion, they do not present results or analysis demonstrating the active use of chamber A. I suggest that the authors include discussion or data analysis illustrating the operation and performance when Tank A is utilized.

Response

We agree that the original manuscript did not clearly distinguish the designed dual-chamber capability from the operating configuration actually evaluated in this study. The differential-pressure mode involving chambers A and B was not experimentally evaluated in the experiments reported here, and we therefore do not introduce unsupported performance data for this operating mode.

The revised manuscript now states explicitly that all performance tests and cloud-formation experiments were conducted in chamber B with the interconnecting valves closed. The dual-chamber configuration and differential-pressure operation are described only as design capabilities of the facility, and their experimental evaluation is beyond the scope of the present study. The title has also been revised so that it no longer implies experimental validation of dual-tank operation.

Comment 2

Line 16: A short explanation is required for "chamber B". Readers might get confused when they will just read the abstract.

Response

We agree. The Abstract now introduces the two chambers before referring to chamber B. It states that the system consists of two interconnected chambers with nominal volumes of 2.7 and 9.0 m^3 and identifies the 9.0 m^3 chamber as the main experimental vessel used for the cloud-formation experiments reported in this study.

Comment 3

Line 96: Could authors explain the term open-closed state?

Response

We agree that the term “open-closed state” was ambiguous and have removed it. The revised Methods now describe the valve operation directly: the three interconnecting valves can be controlled independently, and they remained closed during all experiments reported in the present study.

Comment 4

Lines 138–139: The authors should clarify the term “homemade” to confirm whether the equipment was custom-built in-house. Furthermore, while Figure 2 presents calibration results for select instruments, data for the “CPC-W003; homemade” unit are missing and should be provided. Finally, please state the sample size used to determine the uncertainty statistics in Figure 2, and clarify the measurement uncertainty associated with both the mode and mean particle concentrations.

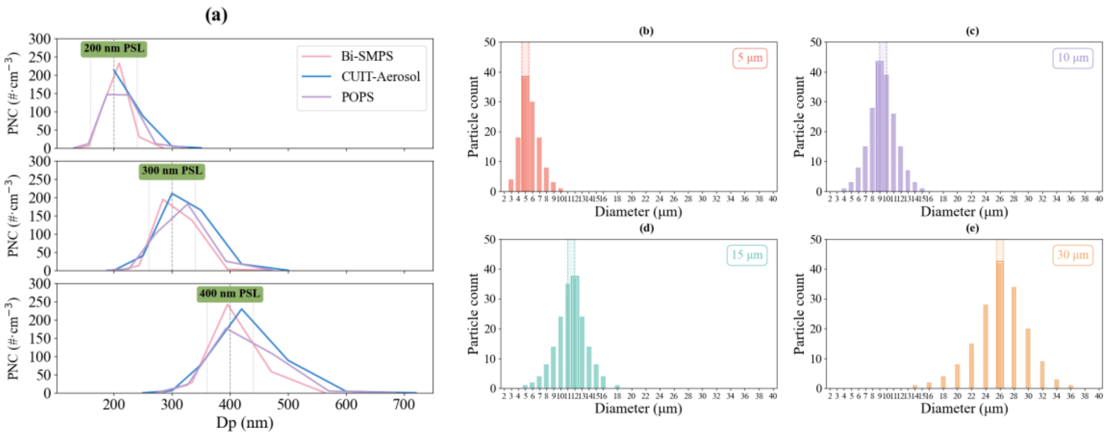
Response

We agree that the former description “homemade” was imprecise. This term has been removed. The revised manuscript now identifies the Bi-SMPS as an instrument developed by Tsinghua University and specifies that it consists of a differential mobility analyzer and a butanol-based condensation particle counter (Model C003, Beijing NaKe Environmental Technologies Co., Ltd.). The former “CPC-W003; homemade” designation is no longer used. The CPC functions as the particle-counting component of the Bi-SMPS and is therefore not treated as an independent particle-sizing instrument in Fig. 2.

Figure 2 has also been revised from the former concentration-based presentation to a quantitative particle-sizing response characterization using Duke PSL standards. For the Bi-SMPS, POPS, and CUIT-Aerosol, Supplement Table S1 reports the retrieved mean diameter, response width, and relative deviation from the nominal PSL diameter. For the FM-120, the total particle counts, retrieved mean water-equivalent diameters, and response widths are reported separately in Supplement Table S2.

The revised Figure 2 no longer presents mode or mean particle concentrations with uncertainty bars. Accordingly, no sample size is used to derive concentration-uncertainty statistics in the revised figure. The reported response width describes the particle-sizing response distribution and is not interpreted as instrumental uncertainty. The former concentration-uncertainty interpretation has therefore been removed.

Revised Figure 2. Particle-sizing response characterization of the measurement instruments using PSL standards. (a) Response of Bi-SMPS, CUIT-Aerosol, and POPS to PSL particles with nominal diameters of 200, 300, and 400 nm. (b–e) FM-120 responses to PSL particles with nominal diameters of 5, 10, 15, and 30 µm.



Supplement Table S1. Quantitative sizing-response characterization of the aerosol instruments using Duke PSL particle standards.

Nominal PSL diameter (nm)	Instrument	Retrieved mean diameter (nm)	Response width, σ (nm)	Relative deviation (%)
200	Bi-SMPS	202.52	18.11	+1.26
200	CUIT-Aerosol	215.63	24.55	+7.81
200	POPS	207.43	23.99	+3.72
300	Bi-SMPS	303.54	28.13	+1.18
300	CUIT-Aerosol	319.15	37.18	+6.38
300	POPS	313.19	35.61	+4.40
400	Bi-SMPS	403.75	35.45	+0.94
400	CUIT-Aerosol	424.26	53.35	+6.07
400	POPS	418.70	48.51	+4.68

Supplement Table S2. FM-120 sizing-response characterization using PSL standards.

Nominal PSL diameter (μm)	Total particle count	Retrieved mean water-equivalent diameter (μm)	Response width, σ (μm)
5	120	5.68	1.37
10	189	9.46	1.92
15	176	11.44	2.14
30	167	26.05	3.72

Comment 5

Line 241: In both cases, ambient air served as the source for the background aerosol; specifying its characteristics such as hygroscopic properties would provide valuable context for the reader.

Response

We agree that additional information on the background aerosol would be useful. The revised manuscript now clarifies that the four warm-cloud experiments were conducted on 7 January 2026 and the two cold-cloud experiments on 2 August 2026. Within each temperature-regime experiment set, all runs used the same ambient-air refill pathway and chamber-reconditioning procedure on the same day, providing a consistent experimental procedure while not implying identical aerosol backgrounds between runs.

No independent chemical-composition or hygroscopicity measurements were available for the ambient refill aerosol; therefore, we do not assign specific hygroscopic properties to the background particles. Instead, the run-specific pre-depressurization size-resolved aerosol distributions are shown in Figs. 7 and 8 to document the initial aerosol loading and its run-to-run variability.

Comment 6

Line 273–275: Sentence may need rephrasing.

Response

Thank you for pointing this out. The sentence has been rephrased for clarity. The revised text now reads:

"Taken together, the closely matched pressure-reduction histories and similar dominant droplet-size characteristics indicate that chamber B produced warm-cloud conditions in four repeated runs under the tested operating procedure."

Comment 7

Line 283: How fog droplet size is different from cloud droplet size?

Response

We agree that the previous terminology could be misleading. In the present chamber experiments, no separate particle-size threshold is defined to distinguish "fog droplets" from "cloud droplets." The term "fog monitor" refers to the instrument designation rather than to a distinct droplet-size category. The revised manuscript therefore uses "cloud droplets" or "droplet-size distributions" when describing the chamber measurements, while "fog monitor" is retained only as the instrument name (FM-120 or CUIT-Fog).

Comment 8

Line 285: The authors should justify the role of collision–coalescence in the chamber or provide relevant literature citations. Given the particle size range observed, it seems unlikely that collision–coalescence would initiate.

Response

We agree with the Reviewer. Given the observed droplet-size range, the original attribution to collision–coalescence was not sufficiently supported by the measurements. We have therefore removed this mechanistic interpretation from the revised Results rather than attempting to infer collision–coalescence without direct evidence. The revised warm-cloud analysis is restricted to the observed FM-120 size distributions, which were dominated mainly by droplets in the 3–10 μm range.

Comment 9

The authors note that the observations are consistent across both warm and cold cloud-seeding experiments. I suggest citing key references that support these findings and expanding the discussion to further explain the results from both cases.

Response

We appreciate this suggestion. In the revised manuscript, the original warm- and cold-cloud seeding comparisons have been removed because the available experiments were insufficient to support quantitative or reproducible seeding-effect conclusions. The retained Results instead present four warm-cloud and two cold-cloud experiments conducted without deliberate seeding or standard-aerosol addition.

The discussion has been expanded to characterize these repeated experiments in terms of pressure-reduction histories, observed droplet-size distributions, and chamber thermodynamic response. Within each temperature regime, the experiments showed closely grouped pressure histories and similar dominant droplet-size ranges. Relevant cloud-chamber studies, including Tajiri et al. (2013), Cotton et al. (2007), Anderson et al. (2021), and recent large cloud-chamber studies such as Park et al. (2025), are now cited to place the cloud-formation procedure and the observed non-ideal thermal response in context. The revised thermodynamic analysis further shows that the measured cooling represented only approximately 10–13 % of the corresponding dry-adiabatic reference, with wall-temperature measurements and the bulk energy-balance analysis indicating substantial non-adiabatic heat exchange during depressurization.

References

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