Response to Editor and Reviewers' Comments

Thank you very much for the reviewers' comments regarding our manuscript entitled "Measurement Report: New insights into the boundary layer revolution impact on new particle formation characteristics in three megacities of China" (Manuscript ID: EGUSPHERE-2025-3637). We sincerely appreciate the insightful feedback provided by the reviewers, which has played a crucial role in improving the overall quality of our manuscript. In response, we have carefully addressed each comment through a systematic revision process, ensuring that all concerns are thoroughly examined and incorporated. The revised manuscript reflects these changes, with all modifications clearly marked in blue within the updated version to facilitate easy review. Furthermore, detailed responses to the editor and reviewers' comments are included below, underscoring our dedication to transparency, academic integrity, and continuous improvement in scholarly communication.

Comments:

Please clarify whether the same model of instruments was deployed simultaneously at the three sites, or whether a set of instruments was rotated sequentially among the sites. How do you ensure the accuracy and comparability of the dataset under the chosen deployment scheme?

Response:

We appreciate the reviewer's question on the instrument deployment strategy and data comparability. In this study, one set of instruments of the same model was rotated sequentially among the three sites, rather than operating three parallel systems simultaneously. The particle number size distributions and PBLH at each site were therefore measured with identical instrumentation and the same operating settings (size range, scan time, averaging period, etc.).

To ensure the accuracy and comparability of the data under this deployment scheme, we followed a unified quality-control protocol: the instruments were calibrated and checked in the laboratory before and after each field campaign. We have added a description of this deployment in the Methods section to clarify how cross-site consistency of the dataset is ensured.

Reviewer comment:

In Section 3.6 "The backward trajectories of particles during NPF events", the HYSPLIT model was applied. However, the starting height was not specified, which needs to be clarified. The sources of air masses in Shanghai are not limited to the northwest direction; a substantial proportion also originates from the southwest and southern regions.

Response:

We thank the reviewer for these helpful remarks. In the revised manuscript, we now explicitly state that the HYSPLIT backward trajectories were initialized at a starting height of 500 m above ground level. This information has been added to Section 3.6 and to the caption of the corresponding figure. We also re-examined the trajectory statistics for Shanghai and agree that, in addition to northwesterly air masses, a substantial fraction of trajectories indeed originates from the southwest and southern sectors.

Reviewer comment:

Many sentences are overly long with multiple clauses. For readability, break them into shorter sentences.

Response:

Following the reviewer's suggestion, we have carefully edited Section 3.6 and other parts of the manuscript to break overly long sentences into shorter, clearer ones, thereby improving the readability of the paper.

Reviewer comment:

Line 12 "all NPF events has been classified"

Response:

Thank you for noting this grammatical error. The sentence has been corrected to:

"All NPF events have been classified …"

Reviewer comment:

Line 61: "High relative humility"

Response:

We appreciate the reviewer pointing this out. "Relative humility" has been corrected to "relative humidity."

Reviewer comment:

Please standardize the placement of (a), (b), and (c).

Response:

We have revised all figures to ensure that panel labels (a), (b), (c), etc., follow a consistent format and placement across the manuscript.

Reviewer comment:

In Fig. 6, the P values for Beijing exceed 160. Please verify whether these values are reasonable. Furthermore, would it be more appropriate to apply a more relevant fitting curve to examine the relationship between boundary layer height and P values?

Response:

We have rechecked the calculation of the dimensionless parameter P. The values in Beijing exceeding 160 were found to be correct based on the extremely low growth rates and elevated condensation sinks during several non-event mornings. We added an explanation in the Results section to clarify this.

Reviewer comment:

Line305: “Fig. 4c and 4d depict the temporal correlation between average PBLH and Vehicular emissions”. Is Fig. 4c and 4d intended to show the relationship between PBLH and vehicular emissions? It should instead reflect the relationship between PBLH and relative time. Please also include the relevant references about vehicular emissions and greenhouse effects to support this point.

Response:

We thank the reviewer for catching this mistake. The original sentence was incorrect. Figures 4c–d show the temporal evolution of PBLH and do not depict vehicular emissions.

The Fig. 4 has been corrected to:

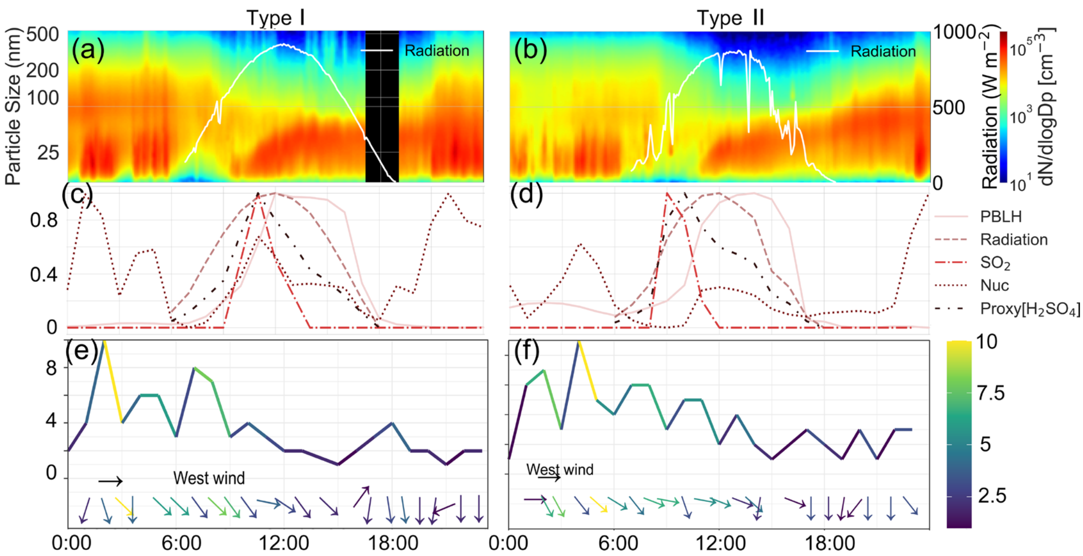

Fig. R1. Representative examples of Type I (left column) and Type II (right column) NPF events in Beijing. Time series of aerosol particle number size distribution: (a) a case from Type I on 24 August 2017 and (b) a case from Type2 on 5 September 2017. Time series of averaged PBLH, radiation, concentration of SO_2, PNC Nuc mode, and proxy[H_2SO_4] for (c) Type1 and (d) type2. Wind speed and direction (e) during the Type 1 case, and during the Type 2 case. Arrows indicate wind direction and color denotes wind speed (m s^{-1})

Reviewer comment:

Line324: "NPF may be primarily driven by low-volatility organics or H2SO4." How do you define cases where aerosol formation is primarily driven by H2SO4? Provide appropriate references to support this definition.

Response:

We thank the reviewer for the valuable comment. We downloaded trace gas and meteorological data for the three sites and calculated H_2SO_4 concentrations. We also investigated the contribution of H_2SO_4 to particle growth, which led us to classify the events into two types (Fig.

R1).

For sulfur compounds and SO_2, we downloaded hourly data from the China National Environmental Monitoring Center and calculated H_2SO_4. We estimated the sulfuric acid proxy [H_2SO_4] based on local solar radiation, SO_2 concentration, CS, and RH (Mikkonen et al., 2011).

$$proxy[H_2SO_4] = 8.21 \times 10^{-3} \times k \times radiation \times {SO_2}^{0.62} \cdot (CS \cdot RH)^{-0.13}$$

where k is the temperature-dependent reaction-rate constant. The relative error between calculated sulfuric acid proxy and measured sulfuric acid concentration is estimated to be 42 % (Mikkonen et al., 2011; Xiao et al., 2015)

Reviewer comment:

Line373: The dots with black borders represent Type I. However, the meaning of the other data points is not explained. Please provide the missing information.

Response:

Thank you for pointing this out. We have updated the figure caption and text to describe all marker styles, including Type II and shrinkage events, ensuring that each symbol used in the plot is clearly defined.

Reviewer comment:

In conclusion, “During the observation period, March and May in BJ exhibited the highest frequencies of NPF occurrence, accounting for 25.9% and 23.8%, respectively.” The data for May are mentioned, but they are not presented or discussed in the main text.

Response:

We appreciate this observation. We have added the missing May statistics to the main Results section and now discuss the seasonal pattern consistently in both the main text and the conclusion.

Reviewer comment:

In summary, the classification is described as two types, but in fact, three types are presented. Please clarify this inconsistency.

Response:

Thank you for raising this important point. Our study classifies NPF events into three types (Type I, Type II, and Type III), while shrinkage events were shown as a separate category for comparison but are not considered a distinct NPF type. We have revised the manuscript to explicitly clarify this distinction and prevent confusion. A sentence has been corrected:

"We identified three distinct mechanisms of NPF initiation: Type I, Type II, and shrinkage. Type I refers to events triggered during the initial rise of the boundary layer, where turbulent mixing associated with PBLH development facilitates nucleation. Type II involves nucleation that occurs only after the boundary layer reaches a certain height (>800 m)."

Mikkonen, S., Romakkaniemi, S., Smith, J. N., Korhonen, H., Petäjä, T., Plass-Duelmer, C., Boy, M., McMurry, P. H., Lehtinen, K. E. J., Joutsensaari, J., Hamed, A., Mauldin Iii, R. L., Birmili, W., Spindler, G., Arnold, F., Kulmala, M., and Laaksonen, A.: A statistical proxy for sulphuric acid concentration, Atmospheric Chemistry and Physics, 11, 11319-11334, 10.5194/acp-11-11319-2011, 2011.

Xiao, S., Wang, M. Y., Yao, L., Kulmala, M., Zhou, B., Yang, X., Chen, J. M., Wang, D. F., Fu, Q. Y., Worsnop, D. R., and Wang, L.: Strong atmospheric new particle formation in winter in urban Shanghai, China, Atmospheric Chemistry and Physics, 15, 1769-1781, 10.5194/acp-15-1769-2015, 2015.