We appreciate the reviewer's careful evaluation of our manuscript, "Performance evaluation of four cascade impactors for airborne UFP collection: Influence of particle type, concentration, mass, and chemical nature." The feedback has been very helpful in identifying areas where the manuscript could be clarified and refined. We have addressed each of the reviewer's comments in detail and have made corresponding revisions to improve the overall quality and focus of the paper. Our responses, along with specific modifications made to the text, are provided below.

This study inter-compares different cascade impactors able to sample UFPs. As the earlier devices based on particle collection by inertial impaction did not have a good size-resolution below 0.1 um, different modifications/extensions of the original impactors were performed. These modified versions implying different underlying principles and design brought a variety of advantages and disadvantages, strengths and weaknesses. Therefore, it is an original idea and a useful task to compare them. It is one of the strengths of this manuscript that the selected devices were compared both under laboratory and field conditions. It is also remarkable that the authors used different test aerosol systems with different properties allowing for the study of evaporation and bouncing, two confounding factors of precise aerosol size distribution measurement. Another strength of the work is the exigent planning, completion and analysis of the related experiments, as well as a precise description of their work and presentation of the results both in the manuscript and in the supplementary material.

Comment 1:

> In the light of the use of modified impactors instead of the original ones an imminent question is the relevance of current results regarding the original impactors. The authors should include a section or paragraph commenting on this important issue.

Answer 1:

Thank you for bringing up this important point regarding the relevance of our results to the original impactors. We agree that discussing the implications of using modified impactors is crucial. In response, we have included sections in the manuscript where we comment on the potential impacts of these modifications. We have also clarified these points more thoroughly in the abstract, methods, and throughout the manuscript to ensure that the relevance of our findings to the original impactors is clearly communicated.

Modifications 1:

L148-151: “Today, several cascade impactors exist, which are either commercially available or newly developed (Crazzolara and Held, 2024; Ngagine et al., 2022; Järvinen et al., 2014; Romay and García-Ruiz, 2023; Marple et al., 2014a; Tsai et al., 2012b). For our comparison, we selected four commercially available models for sampling atmospheric UFP that cover different designs, flow rates, and stage numbers. Additionally, we wanted to sample all ≤100 nm particles on one substrate without further separation. Moreover, we envisioned the use of an automated filter changer in future applications which would be possible with all selected models. Some of these selected impactors required minor adjustments to make them suitable for achieving the final cut-off diameter at 100 nm. Apart from these adjustments, which are outlined in the following, the cascade impactors were operated as described by the manufacturers”

L165: “In this study, we modified the 120R MOUDI by removing the 0.56 nm stage (including the nozzle and impaction plates) located below the 100 nm cut-off diameter stage. This modification allowed us to collect all particles ≤100 nm in the original after-filter holder mounted at the impactor outlet.”

L193-197: “For this study, we extracted the cascade impactor component from the ELPI and considered it as a standalone impactor without the charger and electrometer. For the collection of UFP, we removed the stages with cut-off diameters of 0.03 and 0.06 µm to achieve a final cut-off size of 0.09 µm at stage 3. To maintain the flow characteristics, secure the impaction plates in the built-in tensioner, and ensure appropriate spacing between the nozzle and collection plates, placeholders were inserted instead. On upper stages, aluminium foil filters (25mm, Dekati) were installed. For collection of UFP, a 37 mm QFF was installed in the after-filter holder provided by the manufacturer.”

Comment 2:

In addition, the authors did not evaluate losses for particles with diameter below 30 nm. They mentioned that „Due to the relatively larger uncertainties in the reference instruments for very small diameters, i.e. d_m <20 nm, we decided to evaluate the particle number concentration at 30 nm for determining the losses in the ultrafine fraction”. As deposition by diffusion increases steeply below this size, it would be important to reflect on this issue, at least by expert judgement or/and using data from the open literature.

Answer 2:

We sincerely thank the reviewer for highlighting this important point. To address this concern and provide greater clarity, we have revised the text accordingly. Specifically, we have emphasized the rationale for starting our analysis at 30 nm, given the high uncertainties associated with measuring very small particle diameters and the significant impact of diffusion deposition below this threshold. Additionally, we have incorporated relevant literature on particle losses in cascade impactors, as suggested, to support our discussion. We have also clarified how the focus on mass-based chemical analysis in our study mitigates the relative influence of such diffusion losses.

Modification 2:

L539-557: “Here, the losses in the UFP range were similar for ELPI, 120R MOUDI and ultraMOUDI. This contrasts with the PENS, which had the smallest loss amongst all tested models with about 6%, likely due to its design with the cyclone pre-separator and only one nozzle plate. We can compare our results to a few other studies, that experimentally determined the loss rate of the MOUDI. Liu et al. (2013) showed a total loss of a MOUDI (Model 110) in the range of 2.9-26.1% increasing with decreasing dp50, which was attributed mostly to convective-diffusion. Similarly, Durand et al., (2014) observed losses by convection-diffusion in cascade impactors with stages designed for ultrafine particles below 100 nm. Ungeheuer et al. (2022) measured losses of 28% and 40% in the Nano-MOUDI (110) for particles with aerodynamic diameter of 32-56 nm and 18-32 nm, respectively. It is thought that diffusion deposition becomes increasingly significant for smaller particles, which can lead to substantial particle losses. As high uncertainties are associated with both MPSS and DMS, when measuring particles with diameters below 20 nm, we could not test this behaviour within out setup. However, a mass based analysis of UFP might be less affected by suchh losses than the measurement of the number concentration.

It has been reported, that particle bounce becomes particularly significant for lower cut-off stages because of the gradual reduction in pressure at each stage, which subsequently leads to a decrease in relative humidity (RH). The reduction in RH in turn can intensify the particle bounce effect (Chen et al., 2011). Pressure dropped most drastically throughout the ELPI, which could be problematic for collecting semi-volatile organic marker compounds (Yao et al., 2022). Knowing that the diameters of cut-off and the effective sharpness of the separation between fine and ultrafine SimSOA particles were comparable for all tested impactors, the impact of losses and particle bounce on a mass based chemical analysis might be significant, which therefore is further investigated in the following.”

Comment 3:

Finally, the manuscript is quite long. If the authors can find a way to compact it without loss of pertinent information, it would be nice. For instance, the introduction could be shortened, but I would let the authors to decide on what to shorten.

Answer 3:

Thank you for your comment regarding the length of the manuscript. In response, we have made adjustments to reduce its overall length. Specifically, we have shortened the introduction and streamlined the description of the measurement methods. Please find these amendments throughout the revised manuscript.