Response to the comments

We sincerely thank the anonymous reviewer for the thoughtful review and constructive comments. We have carefully considered all suggestions and revised the manuscript accordingly. The reviewer comments are in blue, our comments are in black, and modifications to the manuscript are in red.

General comments:

As stated by the reviewer, the authors have revised the manuscript carefully in response to previous comments, and the paper has improved substantially. However, a few minor technical and editorial corrections are needed for improved clarity. Additional private note (visible to authors and reviewers only):Please address the minor comments provided by the reviewers.

We sincerely thank the Editor for the thoughtful and constructive feedback on our manuscript. We also appreciate the reviewer's positive recommendation for acceptance. In response to the request for minor revisions, we have corrected the manuscript as detailed below.

Minor Comments

Line 218: The authors may consider explicitly including NOA at this point and introducing a dedicated subsection (e.g., Section 3.1.2.1). This may improve clarity, but I leave the final decision to the authors.

Thank you for this helpful suggestion. We have restructured the discussion by introducing a dedicated subsection for NOA (Section 3.1.2.1) to improve clarity and organization.

Lines 243–245: Please point out which figure represents the trajectory that you mentioned here.

We agree that this was missing. We have now explicitly cited Fig. S8 in the revised text to refer to the relevant air mass back-trajectories.

Lines 301–305: This paragraph appears closely related to the discussion in the first paragraph of this section (Lines 247–261), where comparisons with other urban sites are already made. I suggest combining these paragraphs to improve conciseness and flow.

Thank you for the suggestion. Following the reviewer's advice, we have combined these two paragraphs to provide a more cohesive discussion of the chemical characterization, mass contribution, and regional comparisons of the NOA factor. The integrated section (now Section 3.1.2.1) reads:

A distinct nitrogen-containing organic aerosol (NOA) factor was resolved in this study, whereas earlier wintertime AMS–PMF analyses in Seoul did not isolate such a component. The NOA factor exhibited the highest nitrogen-to-carbon (N:C) ratio (0.22) and the lowest oxygen-to-carbon (O:C) ratio (0.19) among all

POA factors (Fig. S2), indicating a chemically reduced, nitrogen-rich composition. The NOA mass spectrum was dominated by amine-related fragments including *m/z* 30 (CH_4N^+), 44 ($C_2H_6N^+$), 58 ($C_3H_8N^+$), and 86 ($C_5H_{12}N^+$) (Fig. 3a). The spectral signature of the factor is defined by the characteristic dominance of the *m/z* 44 fragment, which typically serves as the primary marker for dimethylamine (DMA)-related species, closely followed by *m/z* 58 (trimethylamine, TMA) and *m/z* 30 (methylamine, MA). This profile is in strong agreement with NOA factors resolved via PMF in other polluted environments. For instance, the dominance of *m/z* 44 and *m/z* 30 aligns with amine factors reported in New York City (Sun et al., 2011) and Pasadena, California (Hayes et al., 2013). This DMA-dominated signature is also consistent with seasonal characterization of organic nitrogen in Beijing (Xu et al., 2017) and Po Valley, Italy (Saarikoski et al., 2012), reinforcing the common chemical signature of reduced organic nitrogen across diverse urban and regional environments.

In this study, NOA contributed approximately 2 % of total OA, comparable to urban contributions reported in Guangzhou (3 %; Chen et al., 2021), Pasadena (5 %; Hayes et al., 2013), and New York (5.8 %; Sun et al., 2011). These similarities suggest that the NOA factor observed in Seoul reflects a broader class of urban wintertime reduced-nitrogen aerosols rather than a site-specific anomaly. Furthermore, the presence of non-negligible signals at m/z 58 and m/z 86 supports the contribution of slightly larger alkylamines, a pattern that aligns well with established AMS laboratory reference spectra (Ge et al., 2011; Silva et al., 2008). In most urban environments, the detectability of NOA appears to depend strongly on the interplay between emission strength, stagnation, and humidity—which together govern the particle-phase partitioning of volatile amines.

Line 442: The decoupling between O:C ratio and volatility has been reported previously in the literature. Consider moderating the wording by removing “striking” and instead emphasizing that this behavior is newly observed or documented for Seoul

We appreciate this constructive comment. We have moderated the language by replacing "striking" with **"notable"** and have emphasized that this is a newly documented observation for the Seoul metropolitan area. The revised sentence reads:

Concurrently, the volatility analysis revealed a notable decoupling between oxidation state and volatility for the More-Oxidized Oxygenated OA (MO-OOA).