# Response to the referee #2

*This study investigates the presence of high nitrite ($NO_2^-$) levels in coarse atmospheric particles at Mt. Qomolangma (Mount Everest) during a spring field campaign in 2022. The researchers found significant enrichment of $NO_2^-$ in total suspended particulates (TSP) but not in fine particles ($PM_{2.5}$). The study suggests that wind-blown soil, which contains high levels of $NO_2^-$, is likely the primary source of this enrichment. Additionally, long-range transport of pollutants from South Asia may contribute to elevated $NO_2^-$ levels, although the specific mechanisms remain unclear. The findings highlight the previously overlooked role of soil-derived $NO_2^-$ in atmospheric chemistry and its potential impact on the atmospheric oxidation capacity in remote regions like the Tibetan Plateau. However, it will be an even stronger paper if the following points are carefully considered. This manuscript can be published after minor revision.*

**Response:** We thank the referee for the thoughtful and concise summary of our work. We have revised the manuscript according to your insightful suggestion.

*Major comments: 1. The study highlights the potential for soil-derived $NO_2^-$ to influence atmospheric oxidation capacity through processes like photolysis or gas-particle partitioning. However, the broader implications for regional and global atmospheric chemistry are not fully explored. A more comprehensive discussion on how these findings fit into larger atmospheric models and their potential impact on climate and air quality would strengthen the study.*

Response: Thank you for this valuable suggestion. Although we can attribute the observed high levels of TSP nitrite to biomass burning and soil emission, the detailed mechanisms for the sources and atmospheric chemistry of TSP nitrite is still unknown and needs further exploration. The implication section has been revised according as follows (lines 587-610): "In the atmosphere, photolysis of particle nitrite can produce OH radical and NO, the latter is essential for the formation of atmospheric oxidants and secondary aerosols (Figure 6). Moreover, the elevated levels of particle $NO_2^-$ may serve as an important HONO source through the gas-to-particle partition process (Vandenboer et al., 2014a), and the thermodynamic equilibrium between particulate nitrite and HONO ([pN(III)]/[HONO] ratio) is primarily governed by the particle acidity and liquid water content (LWC) in theory (Fountoukis and Nenes, 2007; Vandenboer et al., 2014a; Chen et al., 2019). Based on the observed TSP $NO_2^-$ and estimated ratio of [pN(III)]/[HONO] (from 4.8 to 10.6, Text S2), we can estimate the potential level of atmospheric HONO if the partition ever occurs at this site (Vandenboer et al., 2014b), and result indicates HOHO would be at 8 ~ 15 pptv, on the same order with the observations in the background atmosphere at a central Tibetan site (i.e., ~ 30 pptv at Namco (Wang et al., 2023)). Given that TSP concentrations usually reach maximum during spring over TP, i.e., $65 \pm 51$ μg $m^{-3}$ at the nearby QOMS station (Liu et al., 2017), our findings suggest that the coarse-particle may serve as a potential source of atmospheric HONO and $NO_x$ assuming the TSP are associated with nitrite. Although the coarse-particle tend to deposit rapidly within hours, their potential to influence local atmospheric chemistry remains important to some extent, particularly considering the frequent dust events in TP (loose arid/semiarid surface, sparse vegetation, and strong winds. Long et al., 2025) and the ubiquity of long-range transport of biomass burning emissions from South Asia during this season. The impact of the TSP nitrite on the budget of NOx, HONO and OH radicals especially in the background atmosphere could be investigated using regional or global atmospheric transport model, once the detailed mechanism regarding the sources and chemistry of TSP nitrite been elucidated. In summary, our results highlight the need for further investigation into the sources, partitioning, and chemical reactivity of aerosol-phase nitrite, particularly in the pristine Tibetan Plateau, where even small inputs of $NO_x$ or HONO can disproportionately affect oxidant budgets and reactive nitrogen cycling."

2. Although the manuscript provides a detailed description of the experimental procedures and results, the discussion on the research background and significance is not sufficiently in-depth. For example, while the importance of the Mt. Qomolangma region is mentioned, key questions such as why the study of $NO_2^-$ in coarse particles is important and the implications of this finding for the global atmospheric chemistry cycle are not thoroughly discussed.

**Response:** Thank you for this suggestion. We have added the research background and significance in various part in the revised manuscript.

In introduction section, we now added the following descriptions regarding on the importance of particle $NO_2^-$ as follows (lines 59-72):"Recent field campaign further highlighted the rapid reactive nitrogen cycling, with nitrous acid (HONO) and particulate nitrite ($NO_2^-$) as important intermediate, also plays an important role in maintaining the strong AOC in TP (Wang et al., 2023). For example, *Wang et al.* reported high-than-expected HONO (~30 ± 13 pptv) in the Namco station, a typical background site in the middle of TP, with HONO sources including $NO_2$ heterogenous conversion, soil emission and particulate nitrate photolysis (Wang et al., 2023). However, a detailed HONO budget analysis indicated these three dominant sources could not account for the observed daytime HONO levels at this background site, implying the existence of additional, yet unidentified, HONO sources. Particulate nitrite likely represents a potential source of HONO through thermodynamic partitioning processes, provided particulate nitrite may be present in significant amounts under favorable atmospheric conditions (Vandenboer et al., 2014a; Chen et al., 2019; Li, 1994). Interestingly, relatively high levels of nitrite ($NO_2^-$) in total suspended particulate (TSP) have also been reported from remote sites of TP, i.e., in a forest site in the Southeast Tibet (~ 140 ng $m^{-3}$) and at the Qomolangma monitoring station (QOMS, ~ 60 ng $m^{-3}$) (Bhattarai et al., 2019; Bhattarai et al., 2023)."

Regarding the implication of our findings, we have revised according to you last comment, please see our response to your last comment.

*Minor comments:*

*1. Line 23. "Atmospheric reactive nitrogen cycling, with nitrous acid (HONO) and particulate nitrite ($NO_2^-$) as important intermediates, is crucial for maintaining the atmospheric oxidation capacity of the background atmosphere on the Tibetan Plateau." Would be better.*

**Response:** Thank you. The abstract was revised accordingly.

2. Line 65, line 128. The terms "TSP" and "total suspended particulates" are used interchangeably. It would be beneficial to use one term consistently throughout the manuscript to avoid confusion.

**Response:** Thank you for pointing this out. We have revised the manuscript to use the abbreviation TSP (total suspended particulates)" consistently after its first definition to ensure clarity and avoid confusion

3. Line 55. In Section "Introduction", the phrase "Atmospheric oxidation capacity (AOC) regulates

the formation of secondary aerosol and the removal of trace gases including $CH_4$" could be shortened to "Atmospheric oxidation capacity (AOC) regulates secondary aerosol formation and trace gas removal, including $CH_4$.

**Response:** Thank you. The sentence was revised accordingly.

**Reference:**


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