The authors thank the editor and anonymous referees for reviewing our manuscript, and particularly providing valuable comments and suggestions. Our responses in form of point-by-point are given.

The authors reported measurement results of nitrogen-containing organic compounds (NOCs) in $PM_{2.5}$ at a regional background site in South Tibetan Plateau. Careful speciation and quantification on NOCs with 60+ samples over 2 months of time span. Concentration levels and variations of main compound classes, including free amino acids, amines and urea, as well as relatively minor ones (in terms of mass concentrations) such as alkyl amides, nitriles, cyclic NOCs, and isocyanates, were discussed. In addition, concentrations of these NOCs and those of other particulate pollutants (e.g, metals and EC/OC) were used to apportion the sources of NOCs at this site. Results suggested that biomass burning and secondary formation were main contributors of NOCs at this site. Furthermore, regional model was used to evaluate the contribution of cross-boundary transport to particulate matter at this site, hinting that such contribution is also important for the NOCs measured. The study is of importance to understand the climate-related pollutants in the less-explored region of Tibetan Plateau. The chemical analysis and data interpretation in this work in rigorous. The manuscript is also clear to follow. I have a few comments as below.
Response: We thank the referee for the positive comments.

Can the authors briefly justify why nitro-aromatic compounds were not included in this study? They are also light-absorbing and can affect climate. The authors hinted on secondary formation of this class of compounds in P11/L394. Is it that the NOx and aromatic VOC level at the regional background site are not high enough to make them important at this site?
Response: We appreciate the reviewer's insightful comment regarding the exclusion of nitro-aromatic compounds in our study. Nitro-aromatic compounds are indeed recognized for their light-absorbing properties and potential impacts on climate. Their secondary formation in the atmosphere, particularly through photochemical reactions involving NOx and aromatic volatile organic compounds (VOCs), is well-documented. Below are the two reasons why they were not included in this study.
1. The methodologies and analytical techniques employed in our study were optimized for the detection and quantification of specific NOCs such as amines, amino acids, and urea. Including a broader range of compounds such as nitro-aromatic compounds would have required additional specific analytical protocols, possibly complicating the study without substantially enhancing the core findings related to the primary sources and impacts of NOCs in the TP region.
2. The regional background site at Gaomeigu, situated at a remote high-altitude location, has relatively low levels of NOx and aromatic VOCs (Wu et al., 2023; Zhu et al., 2020) compared to urban or industrial areas. The low ambient concentrations of these precursors reduce the likelihood of significant secondary formation of nitro-aromatic compounds in this specific environment. Consequently, the concentrations of nitro-aromatic compounds were not expected to be a major factor influencing the overall

NOC levels and their climatic impacts in this region.
Despite the exclusion of nitro-aromatic compounds, we acknowledge their importance and the potential value of including them in future studies.
In the revised text in Section 3.5, it now reads, "…The complex atmospheric chemistry leading to secondary NOCs includes the oxidation of precursor compounds such as volatile organic compounds (VOCs) and nitrogen oxides ($NO_x$). Other NOCs that were not measured in this study, such as nitro-aromatics, were likely contributing to the NOCs and will be the focus of future research..."

I have some reservation on using regional model to estimate $PM_{2.5}$, and then infer that NOCs are also dominantly transported from nearby regions. High $PM_{2.5}$ might not necessarily mean high NOCs. It is better to build a stronger linkage between the model results of $PM_{2.5}$ and the PSCF results of NOCs, such that the conclusion of regional transport of NOCs would be more convincing.
Response: We appreciate the reviewer's critical assessment regarding the use of a regional model to estimate $PM_{2.5}$ and the inference that NOCs are dominantly transported from nearby regions.
While our regional air quality model primarily estimates $PM_{2.5}$ concentrations, we performed additional analyses to correlate these model results with measured NOC concentrations. As shown in the revised Fig. S12, during pollution periods, NOCs levels were also higher with biomass burning and secondary sources contributing over half of the total NOCs. The PSCF analysis identified source regions contributing to high NOC concentrations, which coincided with regions indicated by the $PM_{2.5}$ transport model, showing similar patterns of PSCF (Fig. S14). This convergence of evidence supports the hypothesis that regional transport mechanisms play a significant role in NOC distribution in the TP.

In the revised text in Sect. 3.5, it now reads, "…during the high NOC events, during high NOC events, such as in EP1, where biomass burning and secondary sources contributed over half of the total NOCs (Fig. S12), the contribution from international transport increased to over 80% for the study area (Fig. 6d)…"
Also, "...However, the marked influence of international transport indicates that $PM_{2.5}$-bound NOC species likely originated from international sources, corroborated by PSCF analysis linking NOCs to specific PMF factors (Fig. S13), and by the observed correlation between bulk PM2.5 and total NOCs (Fig. S14)..."

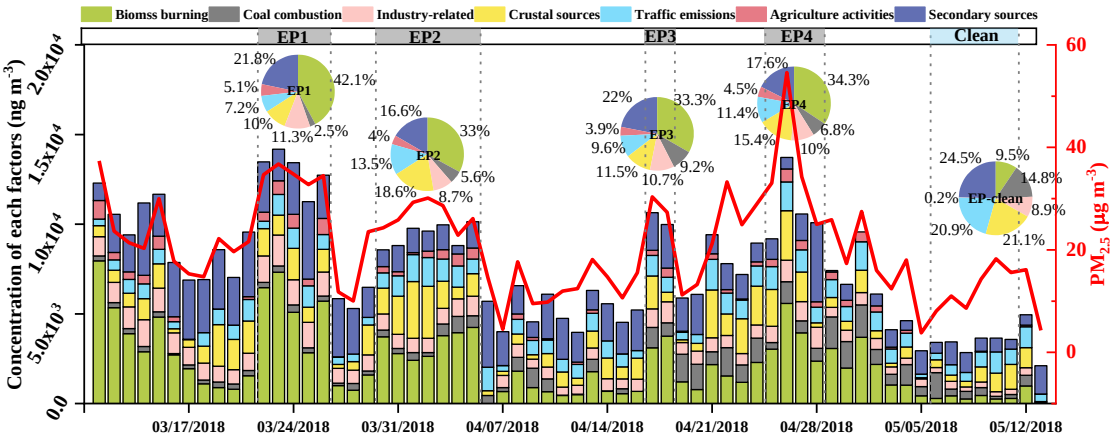


**Fig. S12** Time series of the PMF factors and their contribution during episode periods (EP1-EP4) and clean period in Gaomeigu. The time series of $PM_{2.5}$ concentrations is also shown on the right y-axis.

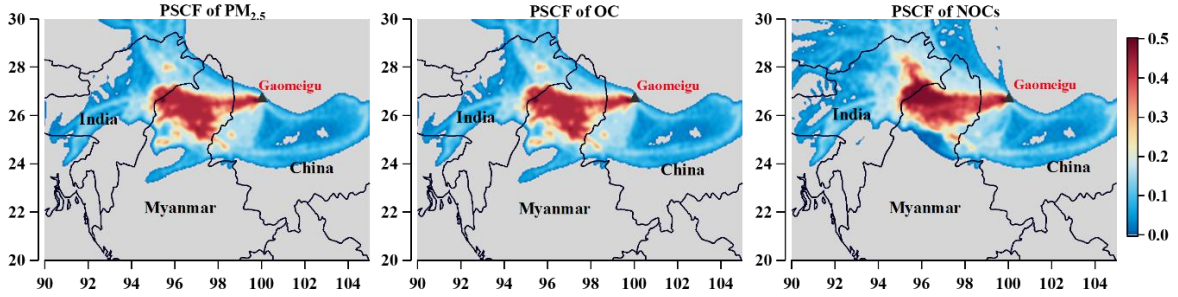


**Fig. S14** PSCF patterns of $PM_{2.5}$, OC and NOC, highlighting similar hotspots from international transport.

I am also a bit confused about how free amino acids are formed secondarily. Do you mean the processes of breaking down proteins into free amino acids, or converting, say amines, into amino acids by introducing the COOH group via oxidation? Please clarify.

Response: The secondary formation of free amino acids in aerosols refers primarily to the processes of breaking down proteins into free amino acids. This can occur through several mechanisms, including direct photolysis, photochemical hydrolysis, and enzyme-based hydrolysis. These processes have been documented in previous studies (Mopper and Zika, 1987; Milne and Zika, 1993; Song et al., 2017). Given that the sampling site is subject to long-range transport, it is likely that free amino acids were secondarily produced by the breakdown of proteins from these processes.

In the revised text in Section 3.2, it now reads, "…Secondary formation of FAAs from proteins can occur through several mechanism, including direct photolysis, photochemical hydrolysis, and enzyme-based hydrolysis (Mopper and Zika, 1987; Milne and Zika, 1993; Song et al., 2017). Given that the sampling site is subject to long-range transport (discussed in Sect. 3.5), it is likely that free amino acids were secondarily produced by the breakdown of proteins during the transport..."

References:

Milne, P. J. and Zika, R. G.: Amino acid nitrogen in atmospheric aerosols: Occurrence, sources and photochemical modification, Journal of Atmospheric Chemistry, 16, 361-398, 10.1007/BF01032631, 1993.
Mopper, K. and Zika, R. G.: Free amino acids in marine rains: evidence for oxidation and potential role in nitrogen cycling, Nature, 325, 246-249, 10.1038/325246a0, 1987.
Song, T., Wang, S., Zhang, Y., Song, J., Liu, F., Fu, P., Shiraiwa, M., Xie, Z., Yue, D., Zhong, L., Zheng, J., and Lai, S.: Proteins and Amino Acids in Fine Particulate Matter in Rural Guangzhou, Southern China: Seasonal Cycles, Sources, and Atmospheric Processes, Environ. Sci. Technol., 51, 6773-6781, 10.1021/acs.est.7b00987, 2017.
Wu, X., Sun, W., Huai, B., Wang, L., Han, C., Wang, Y., and Mi, W.: Seasonal variation and sources of atmospheric polycyclic aromatic hydrocarbons in a background site on the Tibetan Plateau, Journal of Environmental Sciences, 125, 524-532, https://doi.org/10.1016/j.jes.2022.02.042, 2023.
Zhu, C.-S., Li, L.-J., Huang, H., Dai, W.-T., Lei, Y.-L., Qu, Y., Huang, R.-J., Wang, Q.-Y., Shen, Z.-X., and Cao, J.-J.: n-Alkanes and PAHs in the Southeastern Tibetan Plateau: Characteristics and Correlations With Brown Carbon Light Absorption, J. Geophys. Res. Atmos., 125, e2020JD032666, https://doi.org/10.1029/2020JD032666, 2020.

P4/L120: define FAAs here.
Response: Now defined. It reads, "...the free amino acids (FAAs)..."

P5/L135: why not using nmol/m^-3 that is consistent with those in the previous paragraphs?
Response: The units used (nmol $m^{-3}$) in the experimental section are the conventional expressions employed in purely chemical analytical methods to represent the concentration of a solution. In subsequent sections, we use units (ng $m^{-3}$) that more directly indicate the mass concentration of NOCs in the air. This approach facilitates comparison with other chemical components of atmospheric particulate matter by using a consistent unit standard.

P6/168: add "solution" after "7-factor".
Response: Added, it now reads "...The 7-factor solution with the constrained matrix is shown in Table S2..."

P7/L210: "EC" or "EP"?
Response: Revised, it should be "EP", it now reads "As shown in Fig. 1, the campaign is segmented into five periods (EP1-EP5) based on meteorological conditions and NOC concentration variations."

P8/L276-278: citation needed.
Response: We add some references about the source of urea in Sec.3.2.2, Line 276-278, it now reads, "Urea can be released into the atmosphere through agricultural activities and biomass burning (Wang et al., 2022), and it can also be formed secondarily in the atmosphere through chemical reactions (Leung et al., 2024)."

Wang, M., Wang, Q., Ho, S. S. H., Li, H., Zhang, R., Ran, W., Qu, L., Lee, S.-c., and Cao, J.: Chemical characteristics and sources of nitrogen-containing organic compounds at a regional site in the North China Plain during the transition period of autumn and winter, Science of The Total Environment, 812, 151451, https://doi.org/10.1016/j.scitotenv.2021.151451, 2022.
Leung, C. W., Wang, X., and Hu, D.: Characteristics and source apportionment of water-soluble organic nitrogen (WSON) in PM2. 5 in Hong Kong: with focus on amines, urea, and nitroaromatic compounds, Journal of Hazardous Materials, 133899, 2024.

P9/L287: subscript for 6 and 20 to be consistent with the notation earlier in the sentence.
Response: Revised, it now reads, "The CPI, calculated as the ratio of the sum of odd-numbered $C_7$-$C_{19}$ alkyl amides to even-numbered $C_6$-$C_{20}$ alkyl amides, helps identify the dominant source".

P9/L297: provide mean +/- standard deviation as in the previous paragraph?
Response: We added the mean +/- standard deviation of $R_{18}$ in Page 9, Line 298. It now reads $R_{18}$ values range from 0.73 to 2.27, with an average of 1.36 ± 0.35, suggesting the alternation between local and long-range transport."

P9/L311: remove "firmly".
Response: removed.

P9/L319: replace "which" with "and they".
Response: Revised, it now reads "These compounds are known to pose health risks (Cheng et al., 2006; Balducci et al., 2012), and they primarily originate from industrial and agricultural activities (Wang et al., 2022; Richardson and Ternes, 2018; Trapp and Eggen, 2013)".

P10/L357: how much is "a portion"?
Response: We added the data to describe the proportion of factor 7 within the total NOCs in Page 10, Line 357. It now reads "This factor accounted for approximately 13% of NOCs".