Response to Comments from Editor and Reviewer

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Title: " Measurement report: Impacts of Thermodynamic and Dynamic Processes on the Vertical Distribution of Carbonaceous Aerosols: lessons from in-situ observations at eastern foothills of LiuPan Mountains, Loess Plateau"

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In the response, the content in **black** font represents the original text from the manuscript, the content in **blue** font indicates additions or revisions, and the content in **red** font is the response to the reviewers' questions and suggestions.

Dear Editor and Reviewer:

Thank you for your and the reviewers' comments concerning our manuscript entitled "Impacts of Thermodynamic and Dynamic Processes on the Vertical Distribution of Carbonaceous Aerosols: lessons from in-situ observations at eastern foothills of LiuPan Mountains, Loess Plateau" (https://doi.org/10.5194/egusphere-2025-3254). Those comments are all very valuable, greatly assisting us in revising and improving our paper, as well as providing important guidance for our research. We have carefully studied the comments and made corrections accordingly, which can be viewed in the revised version of our manuscript. The main corrections in the paper and the responses to the reviewer's comments are provided below:

1. Additional feedback from Reviewer 2 has been received:

"I really appreciate that the authors provided such a detailed response to my comments. I think almost all comments have been well addressed. However, I am still not convinced by the absorption data at high RH. It is a well-known issue that all filter-based absorption measurements will be biased when RH is greater than 40% (see: https://acp.copernicus.org/articles/13/10609/2013/acp-13-10609-2013.pdf;

https://amt.copernicus.org/articles/12/5879/2019/; and https://agupubs.onlinelibrary.wiley.com/doi/10.1029/2002JD002165). I understand it is challenging to add a dryer to the TBS, and the authors have already put lots of effort into collecting data. I would also not neglect the potential value of this work for improving our knowledge of vertical light-absorption aerosol profiles. However, I strongly encourage the authors to include a discussion of their limitations and potential uncertainties in measurements under high RH conditions."

While this is not a "major" revision, please address Reviewer 2's concern by including a discussion on these limitations prior to acceptance for publication.

Response: We thank the editor and reviewers for this constructive improvement suggestion. We have added a discussion on the influence of high relative humidity on the observational results of carbonaceous aerosols in Section 3.1.3 of the manuscript. In addition, we have pointed out this limitation in the conclusion section of this study and put forward the suggestion of adding a drying device to improve the accuracy of the observational results. The specific revisions are as follows:

3.1.3 Diurnal variations of AAE profiles

Additionally, RH can affect carbonaceous aerosol measurements by the MA200 or MA350 instruments. Water vapor forms a thin film on the PTFE filter membrane, which acts as a refractive index matching layer, enhancing light transmittance and reducing the optical attenuation signal. This results in a negative bias in the measured carbonaceous aerosol light absorption coefficient and mass concentration (Arnott et al., 2003; Düsing et al., 2019; Zieger et al., 2013). To prevent measurement artifacts caused by elevated RH, Arnott et al. (2003) reported that RH should be maintained below 65% during carbonaceous aerosol observations, while the WMO/GAW Report No. 227 (WMO/GAW, 2016) proposed a more stringent requirement of RH < 40%. To mitigate RH effects on measurements, Düsing et al. (2019) developed an autoregressive moving average model with exogenous variables to correct observations obtained under high RH conditions. This approach fits the instantaneous RH changes and the exponential recovery behavior of the instrument response to RH variations, thereby quantifying the

RH-induced bias in the measured carbonaceous aerosol light absorption coefficient. However, the authors explicitly recommended against applying this correction scheme because it requires different fitting parameters for different experimental conditions and the associated uncertainties remain incompletely quantified. In this study, the sample RH measured by the MA350 instrument ranged between 30% and 60% (Fig. S1). Although some measurements were influenced by relative humidity, the data can adequately capture the basic characteristics of the vertical distribution of carbonaceous aerosols over the Chinese Loess Plateau. To further improve measurement accuracy, we strongly recommend that future studies incorporate a drying system upstream of the measurement instrument to minimize RH effects on the observations.

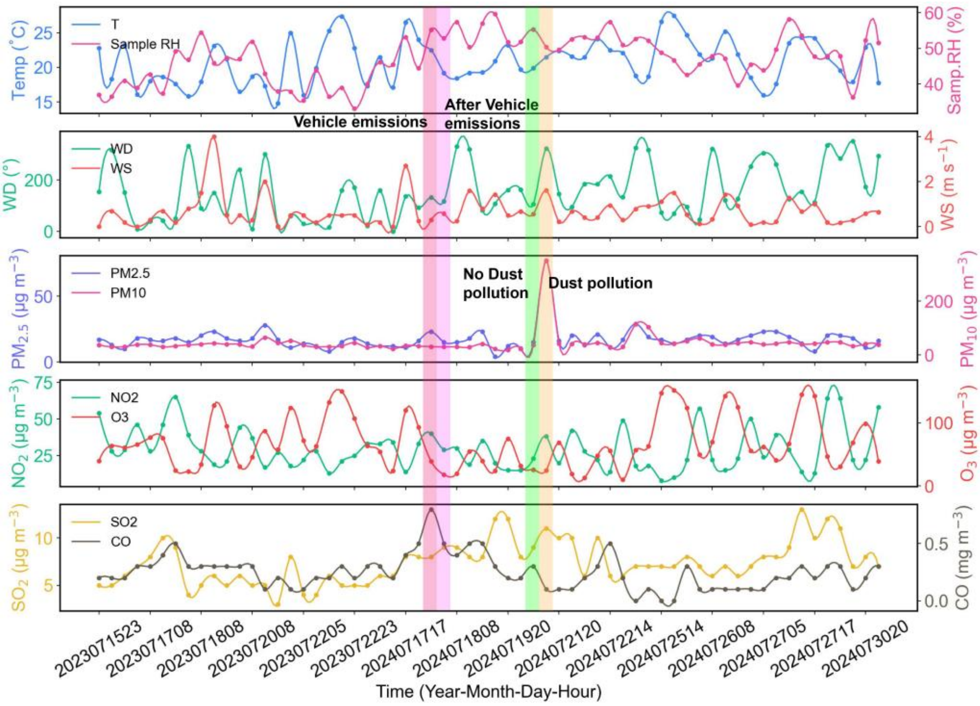

Figure S1. Temporal variations of meteorological parameters, including air temperature (T), relative humidity (RH), wind direction (WD), wind speed (WS), and air pollutants, including particulate matter with aerodynamic diameter smaller than 2.5 μm ($PM_{2.5}$) and than 10 μm (PM_{10}), nitrogen dioxide (NO_2), ozone (O_3), sulfur dioxide (SO_2), and carbon monoxide (CO), were observed during the monitoring period. The shaded areas in the figure represent the during and after vehicle emissions, no dust pollution, and dust pollution at 20:00 on July 17, 23:00 on July 17, 2024, 08:00 on July 20, 2024, 08:00 on July 21, 2024, respectively.

4 Conclusions

Nevertheless, there are still some limitations in this study that should be addressed in future work. Firstly, observations under strong wind conditions in the upper air were not successfully conducted during the campaign. Secondly, the study primarily focused on a limited set of air pollutants. Future research will incorporate additional gaseous pollutants such as SO_2, NO_2, O_3, and VOCs to enable a more comprehensive analysis of the chemical formation mechanisms and vertical distribution characteristics of aerosols. Thirdly, elevated relative humidity can induce a negative bias in the MA350 measurements of carbonaceous aerosol light absorption coefficient. To improve measurement accuracy, we strongly recommend that future observational studies incorporate a drying system upstream of the measurement instrument to eliminate RH effects on the observations. Furthermore, the filed campaign was conducted at only a site, and thus the feedback between aerosols and the PBL meteorology cannot be fully understood at whole Loess Plateau. The upcoming field campaign will be conducted at the other sites to better reveal the impact of thermodynamic and dynamic processes on the vertical profiles of air pollutants.

References

Arnott, W. P., Moosmüller, H., Sheridan, P. J., Ogren, J. A., Raspet, R., Slaton, W. V., Hand, J. L., Kreidenweis, S. M., and Collett Jr., J. L.: Photoacoustic and filter-based ambient aerosol light absorption measurements: Instrument comparisons and the role of relative humidity, J. Geophys. Res., 108, 4034, https://doi.org/10.1029/2002JD002165, 2003.

Düsing, S., Wehner, B., Müller, T., Stöcker, A., and Wiedensohler, A.: The effect of rapid relative humidity changes on fast filter-based aerosol-particle light-absorption measurements: uncertainties and correction schemes, Atmos. Meas. Tech., 12, 5879–5895, https://doi.org/10.5194/amt-12-5879-2019, 2019.

WMO/GAW: Aerosol measurement procedures guidelines and recommendations 2nd edition, GAW Rep. 227, World Meteorological Organisation, Geneva, Switzerland, available at: https://library.wmo.int/doc_num.php?explnum_id=3073 (last access: 9 February 2026), 2016.

Zieger, P., Fierz-Schmidhauser, R., Weingartner, E., and Baltensperger, U.: Effects of relative humidity on aerosol light scattering: results from different European sites, Atmos. Chem. Phys., 13, 10609–10631, https://doi.org/10.5194/acp-13-10609-2013, 2013.

2. Validation. With the next revision, please add a full citation to your DOI link https://doi.org/10.5281/zenodo.17947573 in the section "References" of the manuscript.

Response: We have added this content to the references, and the additions are as follows:

Code/Data availability.

The air pollution data were downloaded from the China Environmental Meteorological Data Service Platform (http://eia-data.com/), and the station ID for Pingliang City is 2656A. The GDAS1 meteorological fields used to drive the backward trajectory calculations were obtained from the NOAA FTP repository (ftp://arlftp.arlhq.noaa.gov/pub/archives/gdas1). Raw data sets (Qi et al., 2025, https://doi.org/10.5281/zenodo.17947573) used in this paper are available at https://zenodo.org/records/17947573 (last access: 16 December 2025).

Reference

Qi, S. F., Zhao, S. P., Yu, Y., Dong, L. X., Zhang, T., Zhao, G., Li, J. L, Zhang, X., Lv, Y. T. Measurement report: Impacts of Thermodynamic and Dynamic Processes on the Vertical Distribution of Carbonaceous Aerosols: lessons from in-situ observations at eastern foothills of LiuPan Mountains, Loess Plateau, Zenodo [dataset], https://doi.org/10.5281/zenodo.17947573, 2025.