

Dear Editor,

Thank you very much for your message and for giving us the opportunity to further revise our manuscript. We have carefully addressed the remaining minor comments from the reviewer as well as the note provided by the editorial office, as detailed below.

Regarding the map shown in Figure 1, we confirm that it falls under case (b), i.e., the map was created by us based on a background layer reused from another originator. Specifically, the basemap used for Figure 1 is the publicly available “World Imagery” basemap provided by ArcGIS. In accordance with your guidance, we have added a corresponding clarification in the manuscript text (Lines 85–86) and included an explicit credit to the ArcGIS “World Imagery” basemap in the reference section (Lines 524–526).

With respect to the comment raised by Reviewer 2, we have provided a detailed response in the point-by-point reply to the reviewer. In addition, we have revised the manuscript accordingly to address this concern, with the relevant changes implemented in Lines 449–451.

We sincerely appreciate the editor’s and reviewers’ time and constructive feedback, which have helped us further improve the clarity and quality of the manuscript. We hope that the current revision adequately addresses all remaining concerns.

Kind regards,  
Qi Zhang and all co-authors

## Reply to Reviewer 2

### General Comments:

The authors have provided a thorough, clear, and well-organized response to all comments raised during the first round of review. The revised manuscript has been substantially improved, and the changes made appropriately address the reviewers' concerns. In particular, the additional explanations and revisions have enhanced the clarity, methodological transparency, and overall quality of the study. After carefully examining the revised version, I find that only one minor issue remains that requires clarification or small revision, as detailed below. This issue does not affect the main conclusions of the paper and can be readily addressed without further analysis. Therefore, I recommend acceptance after minor revision.

### Reply:

We sincerely thank the reviewer for the careful re-evaluation of our revised manuscript and for the very positive and encouraging comments. We are pleased to hear that the revisions have substantially improved the clarity, methodological transparency, and overall quality of the study, and that our responses have adequately addressed the concerns raised during the first round of review.

We also appreciate the reviewer for pointing out the remaining minor issue. As detailed in the response below, we have carefully addressed this point through clarification and a small revision in the manuscript. We believe that this revision further improves the presentation of the work without affecting the main conclusions.

Thank you again for the constructive feedback and the recommendation for acceptance after minor revision.

### Specific Comments:

Regardless of the data source, when the same set of observations is used as reference, the RMSE is generally expected to be larger than the corresponding mean bias (MB), since RMSE incorporates both systematic and random errors. This should hold consistently for the proposed method, the baseline method, and the reanalysis products when evaluated against the same observations. However, the results presented in the revised manuscript appear to violate this basic relationship in some cases. I therefore suggest that the authors carefully re-examine the calculation and presentation of the RMSE and MB, including the definitions, units, and averaging procedures, to ensure consistency and correctness.

### Reply:

We fully agree with the reviewer's comment that, when evaluated against the same reference observations, the RMSE is generally expected to be larger than the

corresponding mean bias (MB), as RMSE reflects the combined effects of systematic and random errors.

To further investigate this issue, we conducted an additional evaluation using independent observations from the Beijing station (WMO ID: 54511) for the period from May to July 2025, applying exactly the same retrieval and validation procedures as in the original analysis. The results show that, for both the retrieved profiles and ERA5, the mean bias is consistently smaller than the corresponding RMSE, in agreement with the expected error relationship. This additional test suggests that, although the original experiments included observations from more than 40 stations, the statistics based on one-month data at individual stations may still be subject to sampling limitations. As can be seen from Figure 1 below (pannel b), the MB of analysis (red line) and ERA5 (cyan line) at 1700 meter above ground level (purple dashed line) stays around 0.55 g/kg and 0.70 g/kg, while the RMSE (pannel e) at the same height is 0.95 g/kg for both the analysis and the ERA5.

In response to this comment, we have made targeted revisions in the manuscript (**Lines 449 – 451**) of the manuscript to improve clarity and consistency, reading as:

“July was selected as the initial test period because the prevailing synoptic conditions over North China frequently give rise to a wide range of convective systems, providing a favorable environment for evaluation; nevertheless, extending the experimental period remains necessary to ensure more robust and statistically representative results”.

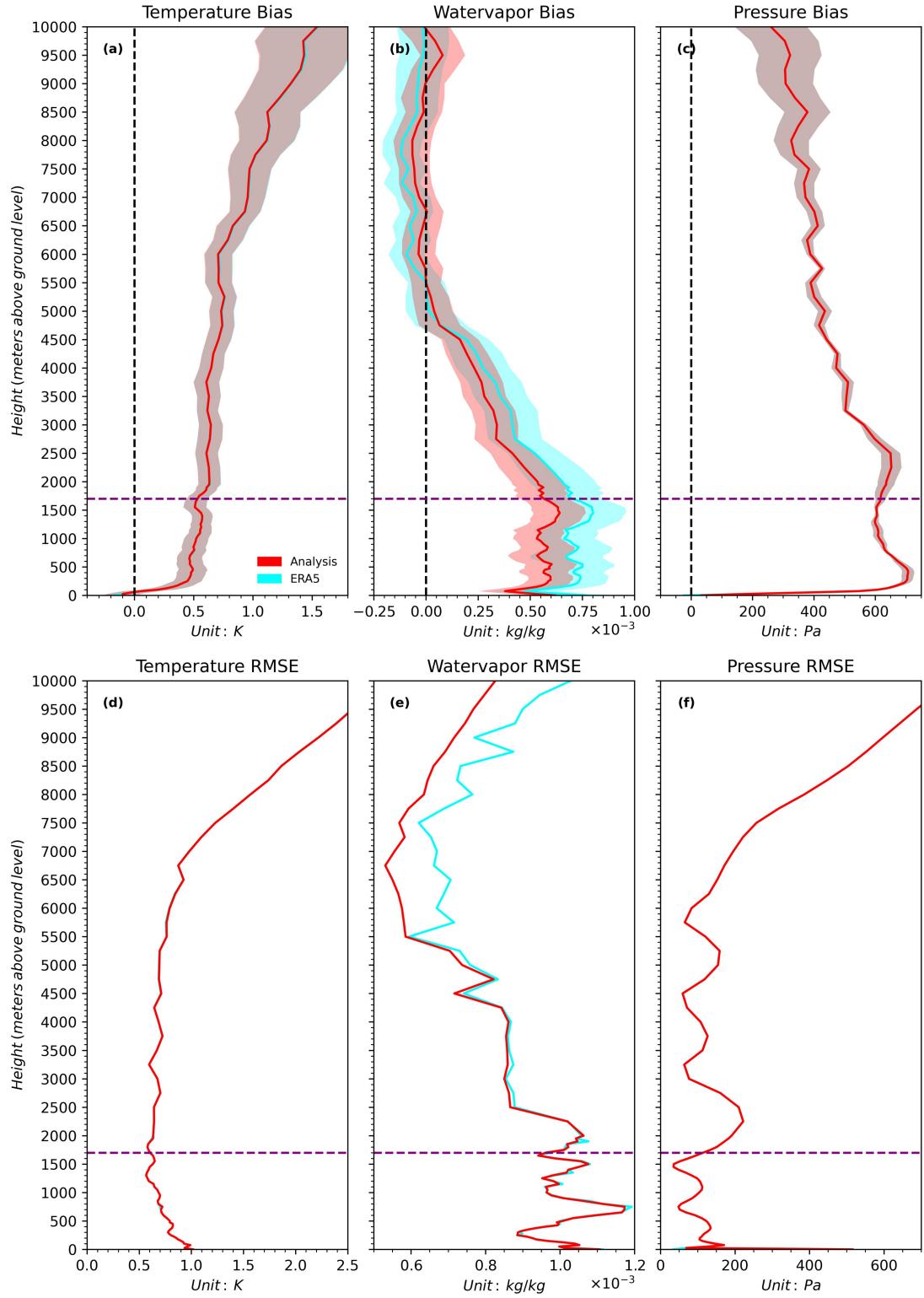


Figure 1. Validation of temperature, water vapor, and pressure profiles retrieved by TCKF1D-Var (red), ERA5 a priori (cyan) against radiosonde observations for Beijing Station (WMO ID: 54511). The shaded areas denote the 95% confidence intervals that have passed the significance test.