# Response to EGUSPHERE-2023-637 Review

Wei Huang , Lei Liu , BinYang , Shuai Hu , Wanying Yang , Zhenfeng Li , Wantong Li and XiaofanYang

Dear editor,
Thank you very much for giving us an opportunity to revise our manuscript. We appreciate the editor and reviewer very much for their constructive comments and suggestions on our manuscript entitled "Retrieval of temperature and humidity profiles from ground-based high-resolution infrared observations using an adaptive fast iterative algorithm" (ID: EGUSPHERE-2023-637). We sincerely thank the editor and reviewer for their valuable feedback that we have used to improve the quality of our manuscript.
We have studied comments carefully and have made extensive modifications which are marked in red in our revised submission manuscript. We have addressed the issues pointed out by the referee, to which we respond in italicized font below. We hope that the referee will find our responses satisfactory, and we are willing to further revise the manuscript regarding any additional suggestions that the referee may have. Please find below the referee's comments in light blue with our responses after each comment.

Kind regards.
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## Referee

Dear Referee:
We would like to express our sincere appreciation for your careful reading and invaluable comments to improve this paper. We have studied carefully on these detailed comments. They are helpful to improve our manuscript. After deep consideration of your valuable comments, we substantially modify the manuscript. Corresponding changes are marked in red in the modified manuscript. Point-by-point responses to your comments are seriously completed for your consideration. If there are still severe issues with our manuscript, please let us know, and we will try our best to modify our article. Thanks for your time!

Replies to the reviewer's comments:

1. Significant figures (see, e.g. https://www.britannica.com/science/significant-figures) - Why are so many significant figures shown? In the abstract it says, "an average retrieval time reduction by 58.82%". Unless this level of precision is somehow important, perhaps just say 59%. For "Convergence rate of 98.67% … slightly lower than 99.88%," perhaps this could be 98.7% vs 99.9%. Similarly for numbers on lines 192-193: use 13% instead of 13.46% etc.

Thank you for your suggestions. We agree with the reviewer that there are too many significant figures shown in the paper. We have adjusted the significant figures throughout the paper and rounded the numbers to 1 digit past the decimal when the precision of the number is not important.

**For your convenience, the modifications to the issues concerned by the reviewer in our revised submission are given as follows:**

*The retrieval speed was significantly improved ..., resulting in an average retrieval time reduction of 59%.*

*... the fast retrieval algorithm reached an acceptable convergence rate of 98.7%, which is slightly lower than the 99.9% convergence rate of AERIoe for the 826 cases used in this study.*

*Both SIC and DFS change slowly with K_Index, as shown in Fig. 2, with the variation of SIC within 13% (from 13.9 to 16.1) and DFS within 4% (from 3.7 to 3.9) for temperature and within 13% (from 1.4 to 1.7) for water vapor,...*

2. The paper still needs to be edited for grammar and clarity in many places.

Thank you for your suggestions. According to your advice, this manuscript was edited for proper English language, grammar, punctuation, spelling, and overall style by one or more of the highly qualified English speakers. We tried our best to improve the manuscript and made some changes in the manuscript. These changes will not influence the content and framework of the paper. Here, we did not list the changes but marked them in red in the revised paper. We earnestly appreciate the Editor/Reviewer's warm and professional work and hope that the corrections will meet with approval.

3. A few points about how their work intersects with the original AERIoe algorithm are unclear to me:

(1) It would be good to state in the paper if/how the reader can obtain the original AERIoe code. I cannot find this in the referenced papers. Does it come with the AERI instrument? Is it proprietary? Can it be purchased?

Thank you for the comments. Unfortunately, we were also unable to obtain the algorithm on the AERI device. The original AERIoe code used in the manuscript was re-written by ourselves on the basis of the work described by Turner and Löhnert (2014).

(2) What programming language is the original AERIoe code written in? C,C++, etc?

To our knowledge, the AERIoe code on the AERI instrument is written in C++ programming language.

(3) How did the authors create their Fast-AERIoe code? Did they modify the original code? Or re-write it?

Thank you for the comments. The Fast AERIoe code was created by modifying the AERIoe code. In this way, the interference of other factors can be excluded and the influence of Jacobian matrix can be highlighted.

(4) The author's state that their new code is written in Matlab. Matlab is a non-compiled code that is not computationally fast. I assume that this is ok because the bottlenecks are computing the Jacobians, and that is done by LBLRTM, which is compiled Fortran code that is therefore fast. Is this the case?

Thank you for the comments. The reviewer is correct. The Jacobians in the Fast AERIoe code are derived from the level analytic Jacobian files in directory AJ, which are created by LBLRTM. The method used to calculate the analytic Jacobians in LBLRTM is faster than the finite differences method.

(5) If so, then I assume LBLRTM writes the Jacobians to files on the disk, which then must be read in by the original AERIoe code or by the Fast AERIoe code. Is this the case? If so, it is possible that

a significant fraction of the time is spent reading and writing from the disk. This could be avoided by calling the Fortran code and passing variables back and forth directly, obviating the need to read/write to disk. I don't know if that can be done with Matlab, but it can be done with Python using f2py. I understand that doing so is probably beyond the scope of this work, but it would be good to know if this is a possible speed-up for future work.

Thank you for the constructive suggestions. The Jacobians need to be recalculated in the retrieval process of AERIoe, which takes up 80% of the total retrieval time. Therefore, reducing the computation of the Jacobian matrix can significantly improve the retrieval speed. However, the time taken to read the Jacobian matrix from the disk is not negligible. The method proposed by the reviewer gives us good enlightenment, and we will explore it in our future work.

Minor edits:

Line 67: change "should be" to "is".

Thank you for the constructive suggestions to improve our manuscript. We have modified the manuscript as suggested by the reviewers.

**For your convenience, the corresponding revised part in our revised submission is given as follows:**

*Additionally, the Jacobian matrix is recalculated for each iteration due to the dependence on the current state vector, which significantly increases the amount of calculation and results in a high retrieval time.*

Line 80: change "will use" to "use".

Thank you for the constructive suggestions to improve our manuscript. We have modified the manuscript as suggested by the reviewers.

**For your convenience, the corresponding revised part in our revised submission is given as follows:**

*We use data collected at the Southern Great Plain (SGP) site, which is located at 36.61 ° N and 149.88 ° W, near Lamont, Oklahoma, USA.*

Line 95: What is meant by redundant data?

Thank you for the constructive suggestions to improve our manuscript. We have corrected "redundant data" to "random error".

**For your convenience, the corresponding revised part in our revised submission is given as follows:**

*AERI has many observation channels, including not only temperature and humidity profile information but also trace gas information such as ozone, methane, and random error.*

Line 167: Should this equation be SIC, not IC?

We sincerely thank the reviewer for the careful reading. As suggested by the reviewer, we have corrected "IC" to "SIC" in equation (3).

**For your convenience, the corresponding revised part in our revised submission is given as follows:**

$$SIC = \frac{1}{2} \ln \det\left(\hat{\mathbf{S}}^{-1}\mathbf{S}_a\right), \tag{3}$$

Line 184: Typo: you forgot n+1. K_index as defined here will always be zero.

Thanks for pointing this problem out. We apologize for our carelessness. In our resubmitted manuscript, the typo has been revised. Thank you for your correction.

**For your convenience, the corresponding revised part in our revised submission is given as follows:**

$$K\_Index = \frac{(\mathbf{X}_n - \mathbf{X}_{n+1})^T (\mathbf{X}_n - \mathbf{X}_{n+1})}{N}, \tag{7}$$

In all, we found the referee's comments are quite helpful. They point the technical issues about our manuscript, also the aspects that we have not done enough. We have tried our best to improve the manuscript and made extensive modifications in the original manuscript according to the comments. Here did not list all the changes but marked in red in revised manuscript. Once again, thank you very much for your constructive comments and suggestions which would help us both in English and in depth to improve the quality of the paper.

Kind regards.

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