Response to the Editor

Dear Editor,

Thank you very much for your careful evaluation of our manuscript and for clearly articulating your main concern regarding its scientific contribution and scope. We fully acknowledge your point that non-ideal instrumental effects in high-resolution FTIR spectroscopy have been investigated extensively over many years and are well recognized within the atmospheric FTIR community. We also appreciate your guidance that, in this context, the novelty and relevance of the present work must be demonstrated through its direct implications for atmospheric trace-gas retrievals rather than through instrument diagnostics alone.

In the original submission, our intention was to present a detailed and systematic characterization of non-ideal instrumental behavior under real operational conditions, with a clear focus on long-term instrument performance and diagnostics. In retrospect, we recognize that this instrument-centered focus did not sufficiently demonstrate how the diagnosed non-idealities translate into atmospheric retrieval outcomes, thereby limiting the broader impact of the study.

In direct response to this guidance, we have substantially revised the manuscript to integrate the instrumental characterization and its atmospheric retrieval implications into a single, coherent study. Rather than treating atmospheric retrievals as a separate or companion investigation, the revised manuscript now embeds retrieval results as a direct extension of the diagnosed instrumental behavior.

Specifically, the empirically characterized non-ideal instrumental response derived from LINEFIT is now explicitly propagated into the forward model within the PROFFIT retrieval framework. The consequences of this propagation are quantified through a targeted case study of ethane (C_2H_6) retrievals from solar absorption spectra measured on 14 December 2012. This case was selected to demonstrate a clear causal link between diagnosed instrumental non-idealities and their measurable impact on atmospheric retrieval performance.

The revised manuscript now demonstrates how the transition from a nominal to a modified instrument configuration affects spectral residuals, retrieval uncertainties, and retrieved total columns. These changes have been consistently integrated across the Abstract, Introduction, Methodology, Results and Data Analysis, Discussion, and Conclusions, embedding the atmospheric application throughout the manuscript rather than presenting it as a secondary addition. The Introduction and Discussion have been restructured to emphasize that the primary contribution lies not in re-establishing known instrumental effects, but in demonstrating how empirically diagnosed non-idealities propagate into atmospheric FTIR retrievals under operational conditions.

We are grateful for your guidance, which has significantly improved the focus, relevance, and coherence of the manuscript. We hope that the revised version now satisfactorily addresses your concerns and meets the expectations for a single, integrated contribution.

Sincerely,
Gezahegn Sufa Daba
(on behalf of the authors)

Response to Referee #1

In the previous review round, under R.C. 1.8, the referee raised a concern regarding the validation of instrument line shape (ILS) characterization and its impact on atmospheric retrieval accuracy. The comment was as follows:

While ILS improvements are shown, there is minimal validation of how these translate to more accurate retrievals of key atmospheric trace gases (e.g., CO, C_2H_6). Concrete examples linking ILS metrics to retrieval errors would strengthen relevance.

A.C.:

We sincerely thank the referee for raising this important point regarding the need to validate how improvements in ILS characterization translate into atmospheric retrieval accuracy for key trace gases such as CO and C_2H_6. We fully acknowledge that explicitly linking ILS diagnostics to retrieval-level impacts is essential for strengthening the atmospheric relevance of the study.

In the previous version of the manuscript, our response clarified that the primary objective of the study was to rigorously diagnose, quantify, and correct non-ideal instrumental effects, and that a comprehensive atmospheric retrieval assessment was not included in order to preserve a focused instrument-characterization scope. At that stage, the validation of ILS impacts on atmospheric retrievals was not demonstrated explicitly within the manuscript.

In the revised manuscript, and following the Editor's guidance, this limitation has been addressed by incorporating an explicit atmospheric retrieval application within the present study. We now demonstrate how empirically characterized non-ideal instrumental effects propagate into atmospheric retrievals by integrating the corrected instrumental response into the PROFFIT forward model and evaluating its impact on spectral residuals, retrieval uncertainties, and retrieved total columns. This retrieval analysis is included directly in the manuscript and provides concrete examples linking ILS characterization to retrieval-level effects. Accordingly, the relevant updates have been implemented across the Abstract, Introduction, Methodology, Results and Data Analysis, Discussion, and Conclusion, ensuring that the connection between ILS diagnostics and atmospheric retrieval accuracy is clearly established in the current version.

Response to Referee #2

In the previous review round, under R.C. 2.7, the referee commented on the need to explicitly demonstrate the impact of non-ideal instrumental effects on atmospheric retrievals by comparing results obtained using nominal and modified instrument configurations. The comment was as follows:

The paper repeatedly emphasizes that accurate modeling of the non-ideal characteristics of an FTS will improve atmospheric measurements. Therefore, it would be appropriate to include a comparison of atmospheric measurements obtained from the instrument using the nominal and modified configurations. There is no need to demonstrate that the results are better, only that they are different and to show how these differences compare to the associated uncertainties. However, the referee noted some hesitation in insisting on the inclusion of the atmospheric results, as this addition may further increase the length of an already extensive paper. The referee suggested that this could be balanced by reducing some of the less essential discussion in the introduction.

A.C.:

We sincerely thank the referee for this thoughtful recommendation. In the original version of the manuscript, our intention was to focus on detailed instrument performance characterization and diagnostics, and to maintain a clearly instrument-oriented scope. For this reason, the atmospheric retrieval analysis was not included explicitly in the manuscript, and the discussion was limited to the diagnosis and correction of non-ideal instrumental effects. At that stage, we indicated that a comprehensive atmospheric retrieval analysis would be treated separately in order to preserve the focus and length of the instrument-characterization study.

Following the Editor's guidance and in line with the referee's recommendation, the manuscript has been substantially revised to include an explicit atmospheric retrieval application within the present study. In the revised version, the impact of nominal and modified instrument configurations on atmospheric retrievals is demonstrated through a targeted ethane (C_2H_6) retrieval. This retrieval illustrates how empirically characterized non-ideal instrumental effects propagate into spectral residuals, retrieval uncertainties, and retrieved total columns.

Accordingly, all text in the previous version referring to a separate or companion atmospheric retrieval study has been removed or updated. The retrieval analysis is now fully integrated into the manuscript, and the relevant updates have been implemented consistently across the Abstract, Introduction, Methodology, Results and Data Analysis, Discussion, and Conclusion. This revision directly addresses the referee's request by demonstrating differences between nominal and modified configurations in the context of atmospheric retrievals, while maintaining a focused and coherent presentation.