Dear Referee,

Thank you very much for taking the time to review our revised manuscript (GMD-2023-173) once again and for providing further valuable feedback. Your suggestive comments have played a crucial role in enhancing the quality and clarity of our paper. We have made some modifications to the manuscript, and the responses are listed below. To guide the review process, comments from the referee and original texts in the manuscript are presented in black, our responses are in blue, and any text modifications made to the manuscript are highlighted in red italics. The line numbers mentioned in this response correspond to those in the revised manuscript. Links are provided below for easy navigation in the document.

We are looking forward to your reply.

Best regards,
Yours sincerely
Sheng Fang

General comments

The authors addressed most of the concerns raised to the earlier version of the manuscript. I appreciate their efforts in making significant changes and adding new contents to the paper. The responses are mostly satisfying.

I would recommend publication after the authors could further address some of the minor issues listed below.

Response to general comments:

Thank you for your valuable feedback and suggestive comments on our manuscript. Your appreciation of our efforts is highly encouraging. We are particularly grateful to hear that our revisions meet most of your expectations. To refine the manuscript, we have carefully reviewed the minor issues you have listed and have addressed them in the revised manuscript.

Minor points

Comment#1:

Abstract, line 17: The definition of the relative source location errors is not universal. Only presenting the values without explaining how the relative errors are defined is not informative.

Response to comment#1:

Thank you for your suggestive comments regarding the presentation of relative source location errors in the abstract. I agree that using the term "relative source location errors" may lead to confusion, since the definition is not universally established. To address this issue, I have replaced the results of the relative source location errors with those of the absolute source location errors.

► Line 15-17 of section "Abstract":

"This method is validated against the local-scale SCK-CEN ^{41}Ar field experiment and the first release of the continental-scale European Tracer Experiment, for which the lowest source location errors are *4.52 m* and *5.19 km*, respectively."

Comment#2:

Lines 69-74: Inaccuracy of the meteorological fields is another major factor that makes the real-world source reconstruction problems challenging. This needs to be included.

Response to comment#2:

Thank you for your suggestive comments. I agree that the inaccuracies of meteorological fields should be highlighted to provide a more comprehensive understanding of the challenges in source reconstruction. These inaccuracies can intensify the challenges of source reconstruction, due to the interaction between the time-varying release characteristics and non-stationary meteorological fields. We have added this point in the revised manuscript.

► Lines 69-74 of section "1. Introduction":

"However, previous studies have also demonstrated that real-world applications may be much more challenging, (Kovalets et al., 2020; Tomas et al., 2021; Andronopoulos and Kovalets, 2021; Becker et al., 2007) because the release usually exhibits temporal variations and may experience non-stationary meteorological fields. *In addition, inaccurate calculation of the meteorological field input can further intensify these challenges.* The interaction between the time-varying release characteristics and non-stationary meteorological fields is neglected in the instantaneous-release and constant-release assumptions, leading to inaccurate reconstruction."

Comment#3:

Line 101, "observation vector composed of observations at N sequential time steps": N should be the number of observations, not the number of sequential time steps. There could be multiple observations at a single time.

Response to comment#3:

We apologize for the incorrect definition of "observation vector". You are correct in pointing out that N should represent the number of observations rather than the number of sequential time steps. To avoid confusion, we have modified it in the revised manuscript.

► Line 101-103 section "2.1 Source reconstruction models":

"where $\boldsymbol{\mu} = [\mu_1, \mu_2, \cdots, \mu_N]^T \in \mathbb{R}^N$ is an observation vector composed of *N observations*, the function **F** maps the source parameters to the observations, i.e. an atmospheric dispersion model, **r** refers to the source location, $\mathbf{q} \in \mathbb{R}^S$ is the temporally varying release rate, and $\boldsymbol{\varepsilon} \in \mathbb{R}^N$ is a vector containing both model and measurement errors."

"

Comment#4:

Line 552, "... and the 50th error level is lower than ...": Please add "percentile" after "50th".

Response to comment#4:

We appreciate your helpful suggestion regarding the clarification needed on Line 552. To avoid confusion, we have added "percentile" after "50th" in the revised manuscript.

► Lines 551-552 of section "3.4.5 Sensitivity to the meteorological errors":

"For Oct. 3, the estimates generally present a low error level (generally below 10%), and the 50th *percentile* error level is lower than the error of the unperturbed results (4.68%)."

Thanks again for such a thorough review!