Simulated plumes freed from meteorology biases using smarter metrics? – response to the reviewers

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1 Answer to referee #1

1. *The authors discuss how to compare satellite observations to simulated concentrations by limiting the weight of modelling errors due to the meteorology used to analyze the observations. The manuscript presents a lot of equations to describe the math behind the method. I'm not sure I fully understand all the details, particularly section 3. But the work generally looks sound to me. I recommend the following revision.*
→ Thank you for your review and for your comments and suggestions on the manuscript. Your main concerns were on the clarity and the transparency of its assumptions, the method used and its goals.

2. *Our view is that meteorology drives the position error between the plume observed and the plume simulated by the CTM. This is the motivation of the work. However, I don't see how solid it is. There are several contributors to the errors. I don't see the reason why meteorology is the driver.*
→ There are likely several other contributors to the position errors. But if one deals with passive tracers and is under the assumption that the temporal variability of the emissions is known, then the position error will be driven by the transport and thus the meteorology. As we mention in the conclusion, it should be interesting to see how sensitive the plume is to the temporal profile in future work. We have modified the introduction to make this point clearer (L. 50-55).

3. *I recommend the author to add a flow chart to demonstrate the method.*
→ We have added a flow chart illustrating the different sources of errors when comparing two plumes (figure 2). Thank you for this nice suggestion.

4. *Line 7. It shall be analyze instead of analyse.*
→ Please note that the article is written in British English, for which the correct form should be 'analyse'.

5. *The concept of pixel-wise norm has been proposed without giving any introduction. Same as double penalty issue, upstream correction, non-local metric optimal transport theory. It will be difficult for readers without strong background for this very specific field to follow. I understand that it is difficult to give the definitions for all those items in a short abstract. I would like to encourage the authors to reconsider the necessity of keeping all those items and the possibility of rephrasing the paragraph in a more reader-friendly way.*
→ Following your suggestions, we have modified the abstract. We hope that it is now more reader-friendly.

6. *Line 40-45. Meteorology is not the only contributor to modelled bias. Such information seems missing from the text.*
→ Once again, you are right, this point requires some clarifications. Accordingly to your early suggestion 2, we have modified (L. 50-55). Indeed, there are others contributors to modelled bias, like the modelling error. But we assume our transport model perfect in the first place. This assumption can be relaxed in future studies.

7. *Line 51. What is "position error"?*
→ Thank you for spotting this issue: indeed, the term 'position error' was not defined at this point. We have reformulated the abstract, and 'position error' has been described as error due to a displacement between two identical plumes(L. 10 and 12), which we believe clearly refers to discrepancies between images due to a translation or rotation. Note that, in addition, the new flow chart (figure 2) should help clarify this term.

8. *Line 47. "the relative weight of the meteorological uncertainties within the comparison between observation and simulation cannot be easily removed through pixel-wise comparison". I don't quite understand the meaning of this sentence. It sounds like the aim of the comparison performed at pixel level is to remove meteorological uncertainties. Please try to rephrase it. Same for "This issue is shared in other fields". I'm not sure the sentence is clear to readers.*
→ The introduction has been reformulated, we hope that it is clearer now.

9. *Line 56. What is droplet or analogous decomposition? Please try to define before use.*
→ The idea of analogous decomposition is that for any state, one can look up in a given large database the typical recorded states close to this state according to some metric. This state can then be approximated as a combination of these closely related states. The droplets are function bases where any signal can be decomposed on.

However, note that in the end, we have removed the reference to these methods, as it introduces unnecessary complexity in the text.

10. *Line 58. What does "fileds" represent here? Line 64. What is a moving field?*
→ This part of the manuscript has been removed for the sake of simplicity and due to the previous comment.