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**Geoscientific
Model Development
Discussions**

Interactive comment on "Quantifying atmospheric transport, chemistry, and mixing using a new trajectory-box model and a global atmospheric-chemistry GCM" *by* H. Riede et al.

Anonymous Referee #3

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This article titled "Quantification of atmospheric transport, chemistry, and mixing using a new trajectory-box model and a global atmospheric-chemistry GCM" describes a new method to evaluate the effect of transport, chemistry and mixing in chemical transport models, via a GCM and a Lagrangian model. The paper layout follows a logical flow and approach is scientifically interesting. A lot of rather obtuse jargon made it hard for me to follow at times, despite my experience with global atmospheric models. This article would be of interest to a wide spectrum of scientists and it would be useful if the wording was equally accessible. In addition, it would be interesting and useful to read an example of how this method could be used to quantify relative importance of chemistry vs. transport, crucial for shorter lived species. Below I state some more

specific comments.

1. Acronyms: I was getting lost in the acronyms, which corresponded to which model with what features. A table would be most helpful. Schematics help a bit, but a table would be a great reference.

2. The justification for using the trajectory model was not clear. Is it for higher resolution? (but the met fields are coming from the GCM, so probably not). Is it easier to separate processes in it?

3. Section 2: I have a hard time following description in paragraphs 4 and 5. What is "undisturbed transport"? What exactly is "the quantification"? Why does mixing ratio at the beginning of a trajectory represent "theoretical contribution of transport?" Is it because there are 3 separate runs? I have a feeling this is all described in the paper, but I had a hard time following.

4. Section 3 heading: "Statistical basis and transferability from the model hierarchy analysis to observations": It is hard to follow complicated language. Does this just say: "Statistical comparison of model to observations?"

5. Section 3, l 21: what is "quantification result"? Is this standard terminology?

6. Section 4: is there really N2 and O2 in the chemical mechanism? I don't think you need to mention it.

7. Section 4, p. 462, l. 12: "what is a waypoint?" Please define for clarify.

8. Section 5, p. 464, l. 16-17: "biomass burning activities in boreal winter." It is more standard and clearer to state months, DJF, for example. Boreal winter in description of BB in Africa sounds confusing.

9. Section 5.2: Looks like only CO was used, which is fine, but it would be useful to mention that mechanism: how many reactions? was OH solved for or kept constant? ie. was the problem linear?. Paragraph 3 needs a citation on the biomass burning.

10. Section 6: Only meteorology was compared to observations, how about species concentrations? There is so much CO data, please include some comparison.

11. Section 7, l. 14: "on-top analysis": what does that mean?

12. Section 7, l. 15-16: "on transfer of quantification results to observations": you mean on model-data agreement?

13. Figure 1: Are CAABA-MJT and CAABA/MJT the same thing?

14. Figure 4: Why would integration points not overlap with trajectory points? Is there a benefit of accuracy etc. to not just interpolate them to the nearest integration time step?

15. Figure 5: I could not follow number vs. placement logic here. I would really benefit from a schematic of waypoints vs. integration points vs. trajectory points, as well as more streamlined definitions of each.

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