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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Transport model diagnosis of the mean age of air derived from stratospheric samples in the tropics" *by* Hanh T. Nguyen et al.

Anonymous Referee #1

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Review on:
"Transport model diagnosis of the mean age of air derived from stratospheric samples in the tropics", ACPD, 2020, by Nguyen, H. T. et al..

In their paper, Nguyen et al. apply two methods (BIR and backward trajectory calculation) to model age of air (spectra) as well as mole fractions of CO_2, SF_6 and water vapour. In the paper, first the model results are evaluated and subsequently some results are compared with data from a measurement campaign. The comparison works reasonably well, with some discrepancies that mostly can be explained.

The overall idea of the paper is good and the method is elaborate. Some of the results are also interesting and can contribute to foster science in this field, although it is for example expectable that chemical SF_6 depletion will not allow direct comparison in the upper stratosphere if it is not included in the model. It is good to carve out which of the modelling methods is suitable to tackle which science question.

However, the paper is chaotic and does not provide the necessary information to follow. Almost nothing is reported about the measurements of that campaign and what are the points that were supposed to be investigated with them. The model description is unclear, I do not understand why sometimes nudging is described, while the authors apply a CTM, which usually is driven (not nudged) by reanalysis data. That is very confusing. The evaluation of the results is pretty lengthy and should be reduced to about two figures. If need be, the rest can be banished to a supplement (maybe together with the appendix). I like the idea of explaining measurements with modelled AoA spectra, but at the end, that is only a minor part in the paper and is only partly successful (partly due to the sinks). However, my main point really is that the study does not follow a clear research question. The reader can be lost due to that. What is it exactly that is puzzling you about the measurements? Why do you think the applied method can help to answer that question and how do you plan on pursuing that? How can additional information about transport processes be gained through that? What is your contribution to improve the undertanding of the underlying processes at the end and how does that fit into existing literature? Some of this information information is lacking, some is spread somewhere across the manuscript, and the reader has to put the pieces together. Further, so many different points are applied, AoA, its spectra, the CO_2 and SF_6 mole fractions as well as water vapour and the cold point are thrown together, but it does not clearly shine through that all these measures are needed to make the conclusions that are drawn at the end. Also, different models, free running, nudged simulations and/or the CTM and the two diagnostic methods, all that leads to confusion and does not help to get to the point. Additionally, intense use of non-intuitive abbreviations complicate reading and also in the results section, many points

are thrown together and a clear focus is missing.

Hence, I would suggest the authors to completely revise the manuscript and then submit it again. I think the study can help to advance our understanding of stratospheric transport and the methods that can be used to investigate it if it is presented and structured properly. Please start with one or more clear research questions that can be answered with this method and build everything around that. Use only the methods needed, describe them clearly, and then take the reader point by point towards the conclusion. Please also consider my additional comments that I am making below.

Additional comments:

- P1L2 A CTM is not nudged! A CTM uses some meteorological fields for describing transport. This is totally confusing and it is not clear to me what is actually done in this study, because later also you talk about GCM and CTM. Please clarify what that is and what you do throughout the paper.
- P1L4: Change “a single” to “the chemistry transport model”
- P1L3-5 The sentence is unclear. Are there discrepancies between the two models or between models and observations? And the following sentence starts with a “This”, but it is unclear what the “this” refers to, to the usefulness, or to the discrepancies.
- P1L7: But where is the connection between the water vapour tape recorder and the mean age here?
- P1L8: Change “the reality” to “good quality” or something alike
- P2L12: Please consider also the newer publication by Engel et al. from 2017 (10.5194/acp-17-6825-2017)

- P2L18: observations and models
- P2L18: With “sampling of clock tracers” do you mean SF_6 and CO_2? Or more tracers? Can you elaborate a little more on the campaign, please, like what, how, how long...?
- P2L21: What exactly is it that is puzzling you about these measurements? This should be central in all parts of the paper.
- P2L25: But that is why the Green’s function is used to flatten out these non-linearities. Please see and possibly mention Fristch et al. 2020 (10.5194/acp-2019-974) and citations therein.
- P3L17-18: So is it a CTM or a GCM now?
- P3L23: It would be easier to use the name of the model from here on, instead of “ACTM”, if the model has a name.
- P3L27: How did the model perform in that inter-comparison? Was it somewhere around the multi-model mean or was it an outlier?
- P4L5: “several years”. Please be precise, for the sake of reproducibility. Did you use ERA-I data of year 2004 for that and repeat that year for ? years?
- Sects. 2.3 and 2.4 are just the evaluation of the model. Firstly, this should be reflected in the section headers, and secondly, these sections should be considerably shortened and/or moved partly to the supplement. I suggest to reduce the number of figures from 5 to 2.
- These abbreviations, particularly “AF” and “AN” do not make much sense to me.
- Fig. 2 I do not fancy that the streamfunction is shown again here, it was shown in Fig. 1 already and does not help much, instead, it disturbs the view on the tendencies. I suggest to remove it.

- P5L15 What do you mean by “selected tracers”?
- P7L1 ...temperature move upward over time.
- P7L6 backward
- P7L15-17 Unclear and awkward phrasing, please rephrase. Plus, what is meant by “not simple”?
- P7L25-26 Remove parentheses around dates
- P7L28 change “drives the tracers upward” to “intensifies the upward tracer transport”
- P7L31 “The vertical axis is ....” What is that sentence supposed to mean? It makes no sense to me.
- P7L32 What is a latitudinal split? Please explain clearly what you talk about. Moreover, why is that important now, you explained the QBO topic already before.
- P8L5 ...the spread of the transit times (Δ)...
- P8L9 A bundle! Please be more quantitative.
- P8L9 the spectra of AoA, CO_2 and SF_6 mole fractions? You are mixing up something here, please be specific.
- P8L11 Can you still give a very brief description of the method of analysis please.
- P8L12-14 I do not understand what this sentence is supposed to mean. Please rephrase it and sharpen the message.
- P8L14 Where do these additional levels come from?

- P8L21 What is CONTRAIL data? Please describe!
- Fig.9 Water “vapour”! Or is ice included too? (Throughout the paper!)
- P9L2 and L5 You already defined these abbreviations above.
- P9L3 But what were the problems in H18? Can you provide a quick introduction? Without that, it is almost impossible to follow.
- P9L18 “It is interesting”. Does that mean the other results are not interesting?
- P9L18-32 Using these abbreviations this way make it almost impossible to follow.
- P9L25 How is that question linked with the general idea of the paper?
- P10L5-9 Even more abbreviations that totally disturb readability.

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