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Atmospheric Chemistry and Physics Discussions

Interactive comment on "How robust are stratospheric age of air trends from different reanalyses?" *by* Felix Ploeger et al.

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We thank the Reviewer for her/his positive judgement of the manuscript and the good comments. In the following, we address all comments and questions raised (Reviewer's comments in italics). Text changes in the manuscript are highlighted in color (except minor wording changes).

General comments:

The paper presents an intercomparison of mean stratospheric age of air and age spectrum for three modern reanalyses using the diabatic model CLaMS. The climatology, seasonality and long-term trends are evaluated, and the results are compare to observations and a previous reanalysis study based on a kinematic model. A large spread in

the climatological values is pointed out, which is however comparable to the range of uncertainty in observations. The seasonality is similar in all reanalyses. The long-term trends are qualitatively consistent over 1989-2015 but less so over shorter (decadal) periods. Overall, the results confirm a long-term acceleration of the BDC consistent with model predictions in response to increasing greenhouse gases. The topic is of high interest, the paper is timely, comprehensive and very well written, and the results are clearly presented. I recommend publication. The only comments I have, listed below, are mostly technical.

Minor and Technical comments:

P7, L1: *Perhaps you could briefly comment the impacts of choosing a given spin-up year.*

In general, the truncation of the age spectrum at a transit time of 10 years causes a young bias in mean age, as discussed in the paper (e.g., P5, L15ff). The age spectra do not include spin-up effects for most parts of the analysis, as we consider the period from 1989 on, which is after 10 preceding years of simulation. Only for MERRA-2, which starts only in 1980, the age spectrum tail (between 9-10 years transit time) includes a remaining spin-up effect in the year 1989, from the preceding spin-up phase using perpetuum 1979 conditions, as explained on P7, L2.

To enable comparison of model mean age to balloon observations in the years before 1989 in Fig. 11, a 10 year spin-up is preceding the main simulation with repeating conditions of the year 1979. All data points before 1989 in Fig. 11 are therefore influenced by this spin-up, with a weaker effect when approaching 1989. This influence only occurs for the comparison of Fig. 11 and is now stated also on P20, L15.

P9, L28: *Remove "Complete".*

Done.

P11, L1-2, P12, L13-14: *Could you be more specific on what is meant by "the tropics-*

extratropics transition is more dilute"? Do you mean the smoother mean age latitudinal gradients or less contrast tropics/extratropics in the age spectrum amplitude values?

Thanks for pointing this unclear formulation out. It is particularly the transition between the tropical and extratropical age spectra which is more dilute, and this is now clearly stated in the revised manuscript.

P13, L2: *Remove "further".*

Done.

P14 L1: *Fig. 7 a-c (add a-c).*

Done.

Fig. 8 caption: *add "annual mean", otherwise one is tempted to compare with Fig. 3.*
Done.

P17 L5: '*"chemical and radiative": Abalos et al. (2019) JGR (https://doi.org/10.1029/2018JD029301) show that the negative mean age trends in the SH are attributed to the ozone hole.*

Thanks for emphasizing this point. It is clarified in the revised manuscript, and the new Abalos et al. paper is cited.

P19 7-9: *This sentence is confusing, it would be better to compare different reanalyses over the same period, not two reanalyses over two different periods.*

The point here is that the differences between different reanalyses are larger for the shorter periods considered. We rephrased the respective sentence to clarify that.

P20 L17: *no conclusion is possible with regards to which reanalysis*

We would keep the former formulation as we think it is clearer in making the point that we can not say which reanalysis is most realistic.

P22 L3: *the qualitative agreement.*

Done.

P24 L4-5: *Unclear sentence: are differences in vertical winds consistent with differences in heating rates (among reanalyses)?*

The sentence should just hypothesize that differences in vertical winds could be similar to differences in heating rates, because the differences in mean age from the simulations driven with either vertical velocity are similar. We rephrased the sentence to clarify that.

P24 L24: *The year of the second reference should be 2016*

Changed.

P25 L12: *robustness in the representation of*

Changed.

P25 L15: *than considering mean age alone.*

Changed.

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