Atmospheric
Chemistry
and Physics
Discussions

Interactive comment on "Quantifying the effect of mixing on the mean Age of Air in CCMVal-2 and CCMI-1 models" *by* Simone Dietmüller et al.

Anonymous Referee #1

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This study presents a thorough comparison of the stratospheric mean age of air among models participating in two comprehensive model intercomparisons (CCMVal and CCMI). They show that there is a slight degradation in the mean age in the more recent CCMI model ensemble, which is biased young relative to observations. Furthermore, the authors show that most of the spread among models is related to differences in mixing, which the authors define in a particular sense as the residual between the mean age and the (idealized) transport times associated only with advection by the residual mean circulation. While I do struggle a bit with defining an "aging by mixing" simply as a residual (as opposed to more conventional approaches using the TLP model) I think this study represents an important contribution. I commend the authors for including both CCMVal and CCMI results in the study, which highlights persistent

problems in stratospheric transport despite (or because of) the incorporation of higher model tops, higher vertical resolution, more sophisticated gravity wave drag parameterizations, etc. I also commend the authors for utilizing a Lagrangian TLP model to illustrate the impacts of vertical diffusion on the mean age. I recommend publication once the comments outlined below are addressed. There are several grammatical errors and awkward phrasing that need to be fixed (some of which are delineated below but should be caught after a more careful reading of the text by the authors).

Minor Comments:

1) It is misleading to say that the approaches in Garny et al. (2014), etc. (lines 11-12, Page 3) first demonstrated that mixing can enhance the ages in the stratosphere. A similar claim is made in line 24 on Page 7. This was first shown by Hall and Plumb (1996) (and studies thereafter), albeit in a theoretical context. This is a major oversight and should be corrected in the text.

2) Some more discussion (with caveats) is needed concerning the trajectory calculations used to infer the "residual circulation transit times." In particular, what contribution do differences in tropopause height among the models contribute to these inferred times? One possibility would be to approximate this by repeating the calculation for one model (with varying tropopause definitions) and/or commenting on previous studies that have looked into the robustness of these calculations.

Other comments:

1) line 5, page 1: "by both, mean transport" -> "by both mean transport by"

2) line 5, page 1: please replace "transport along the residual circulation" with "transport by..."

3) line 16, page 2: "it is the only possible observation-based measure of the BDC" -> This is not true. Previous studies have constrained related aspects of the transport circulation (the age spectrum) using combinations of CFCs (e.g. "Estimation of

stratospheric age spectrum from chemical tracers" by Schoeberl and Douglass (2005)). Please rephrase.

4) line 9, page 3: remove comma after "both"

5) line 3, page 7: "Stratospheric mean age of air is defined as the residence time" -> The mean age and mean residence time are distinct quantities, as outlined in Holzer, Orbe and Primeau (2012). Please replace "residence time" with "transit time".

Holzer, M., C. Orbe and F. W. Primeau. "Stratospheric mean residence time and mean age on the tropopause: Connections and implications for observational constraints." Journal of Geophysical Research: Atmospheres 117.D12 (2012).

6) line 13, page 7: Please fix the latex error.

7) line 4, page 8: "At the same time" -> I'm not sure this is the right clause to use.

8) line 5-10, page 10: It is not clear how you're defining the mixing efficiency. It would be easiest to write out the analytic expression right after the sentence beginning with "The mixing efficiency can be calculated ...". Something along the lines of the discussion in line 11 on page 17, but here.

9) line 29, page 9: Indeed the discrepancy between the ACCESS and NIWA models is concerning!

Figures 1 and 2: It would be good to align the figures as much as possible so that the reader can easily see the projection/degradation of the mean ages among the same models (e.g. move ULAQ, GEOSCCM, SOCOL rows).