

Atmos. Chem. Phys. Discuss., referee comment RC1  
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## Comment on acp-2021-934

Anonymous Referee #1

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Referee comment on "How can Brewer–Dobson circulation trends be estimated from changes in stratospheric water vapour and methane?" by Liubov Poshyvailo-Strube et al., Atmos. Chem. Phys. Discuss., <https://doi.org/10.5194/acp-2021-934-RC1>, 2021

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This study uses CLaMS output to investigate the use of water vapor and methane variability to estimate trends in the stratospheric mean age of air. Estimates based on approximations that have been used in observational studies of this type were compared to the 'true' model trends to identify issues in the approach. This revealed significant errors due to the approximations, although the errors were offsetting during one of the time periods. A method of improving one of the approximations was put forth and shown to improve trend estimates.

The analysis is well done and may help with deducing trends in the stratospheric circulation from trace gas observations, which has been notoriously difficult. The topic is appropriate for ACP, the methods are clearly described and the figures are well done. I suggest the manuscript be accepted for publication with consideration of the minor comments below.

Specific comments:

Line 43: 'CO<sub>2</sub> has a seasonal cycle...'

Line 55: awkward phrasing 'for other than', maybe 'compared to' instead?

Line 77: 'Also in our consideration is meant that there are no any' is hard to understand. Perhaps rephrase to 'The only significant source of H<sub>2</sub>O considered here is CH<sub>4</sub> oxidation (e.g. we neglect all other hydrocarbons...'

Line 179: 'depths of the BDC' is unclear. Maybe 'vertical transport by the BDC'.

Figure 1 caption: I would suggest moving the last two sentences of the caption up into Section 2.1 since they describe important details of the CH<sub>4</sub> boundary conditions for the model run. Why is the CH<sub>4</sub> boundary condition changed from NOAA to AIRS after 2011?

Line 208: remove 'used', '...and the method of calculating FRF.'

Figure 2 caption: 'lapse' is misspelled

Figure 6 caption: The text in the parenthesis after 'FULL' and 'APPROX' isn't necessary since it's partly repetitive from the Figure 5 caption and is explained in the text.

Line 367: '...stems from the differences in the AoA-FRF correlations used in each method...'

Line 373: '...discussed earlier in the paper...'

Figure 7: The constant FRF-AoA correlation approximation appears to bias the AoA trend too positive over both time periods and nearly all the stratosphere. Although you don't try to improve the APPROX method with an improved treatment of the FRF-AoA correlation it seems there might be a simple correction made for the positive trend bias. The interesting aspect is that the age trend biases are largest at the youngest ages, whereas the correlations shown in Figure 4 have no discernable differences either seasonally or latitudinally at ages younger than 3-4 years. This would be worth discussing further.

Line 413, Appendix B: I don't really understand the partitioning of the age into constant values in seven zones. Why not just use the actual age at each location? Is it too computationally expensive?

Line 429: Remove second 'method' in this line.