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Comment on acp-2021-934

Anonymous Referee #2

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-RC2>, 2021

Review of ACP-2-21-934

"Estimating Brewer-Dobson circulation trends from changes in stratospheric water vapour and methane" by Liubov Poshyvailo-Strube, Rolf Müller, Stephan Fueglistaler, Michaela I. Hegglin, Johannes, C. Laube, C. Michael Volk, and Felix Ploeger

Paper Review

This is an interesting and well written paper, but overly detailed. I recommend that the authors take some time to significantly reduce the content to the salient points, briefly summarizing the experiments and driving toward the main conclusions (which are a little nebulous). Concensing and consolidating the paper would improve the focus and make it more accessible to the reader.

Summary

The basic idea, as I understand it, is that the authors want to use measurements of water vapor and methane to determine trends in the BDC. If there is a trend in the BDC it should show up as a change in the age of air in the upper stratosphere (faster BDC → younger air). This paper is about how to accurately diagnose any trend using those tracers. Accurately reconstructing the age spectrum from two tracers will be problematic since there probably won't be enough information to characterize the whole spectrum (see

Schoeberl et al., 2005), but it seems likely that the AoA estimation from these long-lived gases should be ok. This paper is about trying different techniques to diagnose changes in BDC using AoA constructed using ERAi and CLaMS.

No actual observations (except boundary forcing of methane and water) are used in this paper.

The authors assess various methods of using model water vapor and methane to determine changes in the BDC, or basically AoA trends and associated errors. I liked the evaluations they produce and an analysis of various errors (Fig. 5), but I think there is WAY too much detail, and the paper could use more of a reminder of the goals in the results section. For example, near the end perhaps you should show only 3 cases – True, Full and Improve Approx. Discussion of the other cases can be put in an Appendix since the average reader will give up while wading through this material. I think about 30% of this paper could be deleted with no loss of information content.

It was interesting that if you assume a simple age spectrum (Eq. 7) rather than try and reconstruct it, the methodology might work (Fig. 8) pretty well. I look forward to the authors applying this technique to real data, and I wonder how observational uncertainty will impact the results given the size of the existing errors.

As an aside, the authors mentioned a number of times that their analysis won't work in the polar regions, yet they show these regions in the figures which is distracting. Perhaps cutting the figures at $\pm 50^\circ$ might be reasonable.