

Interactive comment on “Investigating stratospheric changes between 2009 and 2018 with aircraft, AirCores, and a global model focusing on CFC-11” by Johannes C. Laube et al.

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Response to Anonymous Referee #2 (RC2).

Reviewer comment

This paper is very well written and well referenced. It makes important contributions to; 1) evaluating comparisons of halocarbon measurements from different sampling platforms over a 10 year period, 2) the use of halocarbon measurements to evaluate stratospheric dynamics in a global model using different meteorological reanalyses, and 3) exploring the use of model derived atmospheric dynamics to examine reasons

C1

for the reduction in CFC-11 global mixing ratio decreases.

Overall this paper is high quality and should be accepted after addressing the few suggestions noted below.

Author response

We thank the referee for reviewing this manuscript and very much appreciate the constructive suggestions.

Reviewer comment

Line 41: The phrase “allow to gauge” is awkward and should be revised.

Author response

We have changed this to “allow to constrain”.

Reviewer comment

Line 88: This is the first use of AoAs and it should be spelled out.

Author response

“AoA” was changed to “Ages of Air (AoAs, i.e. average stratospheric transit times, see section 3.1 for more details)”.

Reviewer comment

Line 90: Polynomial fit functions of what? I suggest adding in “of AoA vs mixing ratio of each species” or something like that.

Line 93: The bootstrap method isn’t explained fully in Laube et al., 2013 so I suggest including Volk et al., 1997 with the Laube et al., 2013 reference here. A bit more explanation would also be helpful.

Author response

C2

The explanation and reference have been added, alongside with an expanded explanation of the methodology, please see our response to RC1 (comment on L90).

Reviewer comment

Line 108: I suggest including a reference to Figures S5 and S6 here.

Author response

Good idea! This has been added.

Reviewer comment

Line 112: I suggest referencing Table S2 for the measurement uncertainties.

Author response

Done. As outlined in our response to comment 2 by RC1 we have also moved Table S2 to the main manuscript.

Reviewer comment

Lines 114-115: The authors state here that Figure 1 illustrates improved temporal density from 2016, which it does, but goes on to say especially at altitudes above 15 km. There is no indication of altitude in Figure 1. As the authors mention, the lower values are from higher altitudes, but there is nothing that says what those altitudes are, and in fact, the values in Figure 1 are not from the highest altitudes: : see next comment re Figure 1.

Figure 1: The mixing ratios for all compounds do not reflect the full range of the combined measurements. The full range for CFC-11 and CFC-12 are seen in Figure 2 and for the other compounds in Figures S1-S4. Please indicate in Figure 1 why this is the case.

Author response

We agree and have modified the caption of Figure 1 to include the relevant information:

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“For all gases except SF6 some higher altitude data are not shown to better demonstrate the good comparability of near-tropopause data to the NOAA time series. The complete corresponding data including uncertainties can be found in the supplement (see also Figures S1 to S4).”

Reviewer comment

Line 146: The authors state the MERRA-2 based data stands out producing higher transport times at similar stratospheric CFC-11 mixing ratios. It should read “higher mean ages”, rather than higher transport times. As the authors say in line 148, this results from slower transport times.

Author response

Changed, thanks!

Reviewer comment

Line 176: I suggest including Figure S7 in the main text so the readers can see all four years rather than going to the Supplementary section for 2 of the 4 years. Line 1 S12 and S13 Figure captions should be MERRA-2 rather than JRA-55.

Author response

We agree and have implemented the requested changes. Figure S7 is now part of Figure 3.

Reviewer comment

Line 217: 2.5 Mass flux estimates of CFC-11 (this labeled 2.4 in the text)

Author response

This has been adjusted alongside with the restructuring of the section in response to RC1 (comment on the Section 2 heading).

Reviewer comment

C4

Figure 4: What are the “two corresponding time series of tropospheric CFC-11 mixing ratios”? The grey solid line represents the NOAA measurements but it’s not clear what the grey dashed line represents.⁸⁴: Please reference Figures S8-S13 for this discussion.

Author response

The respective statement in the figure caption was modified to “Shown in grey and on the right hand y-axis are the two corresponding time series of tropospheric CFC-11 mixing ratios (i.e. the real one, solid, and the one with the forced decrease, dashed).”

Interactive comment on Atmos. Chem. Phys. Discuss., <https://doi.org/10.5194/acp-2020-62>, 2020.