

Atmos. Chem. Phys. Discuss., referee comment RC2 https://doi.org/10.5194/acp-2022-650-RC2, 2022 © Author(s) 2022. This work is distributed under the Creative Commons Attribution 4.0 License.

Comment on acp-2022-650

Anonymous Referee #2

Referee comment on "Observed changes in stratospheric circulation: decreasing lifetime of N_2O , 2005–2021" by Michael J. Prather et al., Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2022-650-RC2, 2022

This is a concise, generally well-presented analysis of the changing N2O stratospheric sink and lifetime. I appreciated the brevity but also think some of the sections could be expanded a bit to improve clarity. The analysis has interesting and important implications, including for climate change-driven changes in the BDC and for the clearance of ozone-depleting substances from the stratosphere. I recommend publication with some minor revisions.

Abstract

The second sentence repeats part of the first sentence and is also a bit awkward, since "it" has no clear singular antecedent. Perhaps rewrite as,

"This is occurring because the N2O abundances in the middle tropical stratosphere, where N_2O is photochemically destroyed, increased at a faster rate than the bulk N2O in the lower atmosphere."

The result that the N2O lifetime is decreasing, even despite the reduced photolysis coefficient in the upper stratosphere due to ozone recovery, seems like an important concept to include in the abstract, since it lends further support to the importance of the increased BDC in driving the decline in N2O lifetime.

The projection to 2100 is quantitative (20% increase) but somewhat speculative, while only a qualitative statement is made about the 2005-2021 trend, even though the calculations over that period are solidly grounded in data. It might be better to include a quantitative estimate of the 2005-2021 trend.

Line 15, I would suggest removing "but relatively minor" since it seems to belittle the findings of this paper and also is not really developed in the body of the manuscript. In general, I think a stronger concluding sentence, which sums up the important implications of this work, would serve the Abstract better.

Other comments

Line 26, "but these observations run counter to the climate model projections (Karpechko et al., 2018; Abalos et al., 2021; Garney et al., 2022)" Can the authors spell out more clearly what the observations are showing for those less familiar with this literature, e.g., are the SF6 observations suggesting no change in the BDC, or are they showing a slower BDC?

Line 59, space => spaced

Line 63, should the second 86 be 84? Otherwise, it doesn't make sense that the dataset extends from 84N to 84S.

Lines 87-94, This argument for the minimal impact of the solar cycle impact might belong in the Results/Discussion rather than the Methods, e.g., grouped together with discussion of other uncertainties like calibration drifts.

Line 101, please clarify which source files have changed.

Line 170, Please include a summary statement to wrap up this paragraph. As currently written, the impact of possible calibration drifts is not clear. Since the conclusions of this paper depend in large part on the relative trends in N2O in the middle/upper stratosphere vs. lower in the atmosphere, it seems important to leave the reader with a clear statement.

Line 2004, proportion => proportionally

Paragraph starting at line 201, This is an interesting side note. Would this change be detected in a decrease in the NOy/N2O tracer correlation slope in the lower stratosphere?

e.g., as discussed in Nevison et al. (1999), GBC, 13, 737-742.