Atmospheric Chemistry and Physics Discussions

Atmos. Chem. Phys. Discuss., referee comment RC3
https://doi.org/10.5194/acp-2022-240-RC3, 2022

Comment on acp-2022-240

Anonymous Referee #3

Referee comment on "Bayesian assessment of chlorofluorocarbon (CFC), hydrochlorofluorocarbon (HCFC) and halon banks suggest large reservoirs still present in old equipment" by Megan Jeramaz Lickley et al., Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2022-240-RC3, 2022

This well-written manuscript uses a probabilistic Bayesian model to quantify residual storage (banks) of multiple ozone-depleting substances that are released to the atmosphere even after their production has been curtailed by regulation. The method appears to be a valuable approach to checking compliance to the Montreal Protocol for multiple compounds, and earlier iterations of this method have been used to infer lifetimes and banks of CFC-11, CFC-12 and CFC-113. From my reading, it appears to mesh fairly well with observation-based approaches that use background concentrations, global transport models, and inverse modeling to derive emissions estimates (e.g., the concurrently submitted paper to this journal on HCFC-142b by Western *et al*). I am not intimately familiar with either modeling approaches, so my goal here is to enhance the readability of the present manuscript to expand accessibility to larger audiences. The following are suggested as items for clarification.

- Introducing the terms "prior distributions" and "priors". It would be helpful to define these terms to help readers who are not familiar with such terminology. Lines 145-147 could be clarified as follows: The input parameters in the simulation model described above require initial values to be assigned, along with their probability distributions. These prior distributions ('priors') are developed to estimate mole fractions, emissions, and banks for CFC-11, 12, 113, 114, and 115, HCFC-22, 141b, and 142b, and halon-1201, and 1311.
- Lines 187-190. This sentence has a grammatical issue. "While there are published estimates of uncertainties in observed mole fractions, the uncertainties in modeled mole fractions do not, therefore, we estimate S separately for each chemical…"
- Table 3 conversions. I'm not sure how to interpret the units for GWP100 and OPD. For the GWP100, is it Gg CO_2 equivalent per year? For ODP, is it Gg CFC-11 equivalent per year?
- Disparities in CFC-115. Because the Bayesian model differs from the observed CFC-115 mole fractions, and the modeled emissions are very different from the observationally-derived emissions, how much confidence should we have regarding the magnitude of the bank estimates or emissions by source for this compound?

- Unexpected differences between Figures 3 and 4. For most compounds, I would expect the emission rate by source (Gg/yr, Fig 4) to be a fraction of the magnitude of the banks (Gg, Fig 3). This is the case for CFC-11, CFC-12, HCFC-22, F141b, and F142b, all of which appear to have an emission rate of ~10-20% of the banks per year. However, CFC-113 appears to have an emission rate that exceeds the entire bank size per year, CFC-114 appears to be 3 orders of magnitude larger, and F-115 appears to be 2 orders of magnitude larger. Is that correct? If so, does that mean that essentially all of those compounds are dispersed immediately (i.e., that banks are inconsequential)? Then why are CFC-115 emissions coming entirely from long-banks? I seem to be missing something important here.
- Different time ranges on x-scale. This is a minor edit, but it would help the reader line up plots if the x-axes for the figures used the same time range. Plots start in 1940, 1950, mid 1950s and 1960.
- In order to contextualize these results with prior studies, it might also be helpful to include the results from Lickley *et al*, 2020 and Lickley *et al*. 2021 on some of the plots.

Overall, this is a useful extension of their prior studies, and the study will shine a light on the discrepancies between what is reported and what is happening in terms of these regulated halocarbons. Given the importance, I think the above clarifications will help make the manuscript more accessible to a broader audience.