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Comment on acp-2021-1070

Anonymous Referee #2

Referee comment on "Projections of hydrofluorocarbon (HFC) emissions and the resulting global warming based on recent trends in observed abundances and current policies" by Guus J. M. Velders et al., Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2021-1070-RC2, 2022

Review of paper

Projections of hydrofluorocarbon (HFC) emissions and the resulting global warming based on recent trends in observed abundances and current policies *Guus J.M. Velders, John S. Daniel, Stephen A. Montzka, Isaac Vimont, Matthew Rigby, Paul B. Krummel, Jens Muhle, Simon O'Doherty, Ronald G. Prinn, Ray F. Weiss, and Dickon Young*

The paper develops a scientifically relevant hydrofluorocarbon (HFC) emission scenario consistent with current observations and policies, and compares it with several other scenarios, especially with the one reported by the main author in 2015. The paper infers that under the newly developed scenario, the HFCs contribution to global warming is significantly smaller than expected by the author in 2015, and explains this with political measures and technical developments implemented in the meantime. The effects of complying with the Kigali Amendment are also estimated and discussed. Changes in HFCF consumption over time are shown for developed and developing countries from 1990 to 2020 and related to replacing HFC substances. Time series of emissions under a variety of scenarios and two different observation based emission estimates are shown for four HFC and the total of the most important HFC species. HFC emission scenarios according to world region and with respect to sectorial emissions are plotted, together with their respective radiative forcings. Various HFC scenarios and their contribution to global average surface temperature 2000-2100 are presented.

This paper is valuable and of interest, also for policy makers and general public, as it presents a detailed description on the HFC emission situation and projection and its relevance for climate change.

Major points to revise:

- The paper needs a discussion on the scientific limitations of the used methods.
- Error discussion, preferably error bars should be provided with given results, without which interpretation of (significance of) results is sometimes difficult.
- The number of observations, and the representativity of stations for the purpose of calculating global averages, and deriving emissions, as well as uncertainty of this value should be discussed for all analysed substances. In the Acknowledgements, it can be found that possibly only 5 stations are used? What robustness can be achieved for the different substances? A plot of the global average concentrations (possibly with variability estimate or confidence interval for the mean value) for all 10 discussed substances would be illustrative. This would allow the lines 449-450 to stay, otherwise line 449-450 has to be removed, as observations and trends are not shown in this paper. Also "ten" is misleading, discussed in this paper are 4 substances and the sum of ten.
- The reference to the 1-box model (line 116) is insufficient to understand how the emissions were derived from concentrations, especially as later there seems to be a split according to regions, sectors and developed/developing countries - how does this fit with a 1-box model? Also in section 2.5, the box model is not described in such a way the reader can understand whether the application of MAGICC6 is fit for purpose. Any error bars coming out of MAGICC6? Are (line281) the mole fractions (used for the purpose of this paper ?) calculated by MAGICCS from the emissions given by the scenarios? How do the mole fraction outputs from MAGICC6 compare to the AGAGE/NOAA observations? Or are in fact the averaged observed values used as an input to MAGICC6?

Minor points:

- Several scenarios are used. They need to be clearly explained, and preferably, memorisable named. A table would help the reader to keep track which ones are compared. My understanding:

Line 33: Scenario A

Line 37: Scenario B1 and B2 (using AGAGE and NOAA/GML, respectively) – why are not data sources from AGAGE and NOAA/GML used together (that would be scenario B3

Line 47: Scenario C1 "current trends and current policies"

Line 48: Scenario C2 "current policies" – here it is unclear whether actually same as C1 is

meant, or whether the omitting of “current trends” marks the difference to C1.

Line 50: Scenario D (Kigali amendments)

Line 51: Scenario E1 “without current policies” … is this the same as scenario A? E1 is surely also without Kigali amendments, line 53 seems to suggest otherwise

Line52: Senario E2: “current policies, but without Kigali Amendment” is this the same as C1?

In the text as well as in the figures, it is sometimes, but not always clear which scenario exactly is meant, e.g.,

Line 420: not sure which scenario of the above is meant, or a new one.

- Location of observations are not shown (as promised in line 114).
- References like “see Sect. 2.1” at line 170 or “see Sect. 3” at line 198/119 are not helpful, also line 117, 132 etc, as no additional information can be found there.
- Reference to figures: include “right” or “left” for clarity, e.g., line 329, 350, 356, 365, 371.
- Line 509: check wording “direct effect of projected emissions” probably better: “effects of direct emissions” (direct/indirect refers to emissions here, not to effects)
- Supplement: Superscripts are indicating the data source. Superscript of a line seems to be valid for al numbers of the line, except when the number has its own superscript (this would be a reasonable rule). There is also a column with a superscript – does the column-superscript predominate the line superscript? Easier would be to apply the same reasonable rule.

I would like to encourage the authors to tackle these major and minor points (from a reader perspective) , as they should be not too much effort from the authors’ perspective and will improve readability and usefulness of this potentially nice paper.