

Interactive comment on “UV and Infrared Absorption Spectra, Atmospheric Lifetimes, and Ozone Depletion and Global Warming Potentials for CCl₂FCCl₂F (CFC-112), CCl₃CClF₂ (CFC-112a), CCl₃CF₃ (CFC-113a), and CCl₂FCF₃ (CFC-114a)” by Maxine E. Davis et al.

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We thank the referee for their constructive comments.

Response to Anonymous Referee #1

I find the uncertainty estimate unrealistic. The uncertainty which is reported here is purely the uncertainty due to kinetical and photochemical data. Not the uncertainty of the derived atmospheric lifetime. One important point in this respect is how fast tropo-

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spheric air is transported to the stratospheric loss region. The model lifetime will thus depend strongly on model transport. I therefore think it is unrealistic to assume that the model can really constrain the atmospheric lifetime this closely. For this, a thorough investigation of model transport would be necessary. I suggest that the authors discuss this point more closely and that they include a discussion on the uncertainty of the atmospheric lifetime due to transport. I further suggest that knowledge of actinic fluxes and the underlying uncertainties should be discussed in the uncertainty estimate.

Author Response: We certainly agree that there is uncertainty in the total derived lifetime due to the model transport uncertainty. However, investigation of this issue would require, for example, multiple sensitivity simulations with varying transport rates used in the same model, or base simulations from multiple models (which have different transport rates). The impacts of this transport uncertainty would then have to be evaluated against long-lived tracer observations, e.g. as done in SPARC Lifetime report, 2013, Chapter 5. However, such an extensive transport evaluation is far outside the scope of the present paper.

As for the actinic fluxes, there is uncertainty, for example, in the J[O₂] and J[O₃] cross sections. But again, addressing this issue thoroughly is beyond the scope of this paper.

In our study, we address only the uncertainty associated with the kinetic and photochemical data and its impact on the total lifetime. For this evaluation, we used a well-established and vetted 2-D atmospheric model that enables us to perform multiple model runs with different kinetic and photochemical input parameters at a reasonable cost. We do not attempt to address all of the processes that would contribute to lifetime uncertainty. This approach, which has been used previously, is used to get a better handle on whether the uncertainty in the lifetime is due to the kinetic and photochemical input parameters, i.e., laboratory data, or the details specific to a given model. Our results show that the uncertainty in the laboratory data is relatively small for these molecules and probably much smaller than the lifetime variability obtained using different models, e.g. the SPARC (2013) lifetime report found lifetime differences of 10-15%

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between different models. That is, the absolute lifetimes obtained from models might differ from our 2-D model calculations, but the majority of the difference is not due to the kinetic and photochemical input parameters.

Action Taken: Some of the confusion on this issue is due to not stating these points clearly in the text. To address both referees' comments on this issue, we have reworded the text in the Abstract, the Atmospheric Implications section, Table 6, and the Conclusions to specifically state that the reported uncertainty ranges in the lifetimes and ODPs are due to the kinetic and photochemical uncertainty. We have removed wording such as "the uncertainty is primarily due to ..." since this can be interpreted as though the other sources of uncertainty are unimportant (e.g. transport, actinic fluxes).

Minor suggestions:

Referee Comment: Introduction: I suggest stating more clearly that only three of the species investigated here have recently been observed and make a statement on whether there are indications of a presence of CFC114a in the atmosphere.

Author Response: We can make this point more clearly in the text.

Action Taken: First sentence in Abstract: "The potential impact of the recently observed CCl₂FCCl₂F (CFC-112), CCl₃CClF₂ (CFC-112a), CCl₃CF₃ (CFC-113a), and CCl₂FCF₃ (CFC-114a) (chlorofluorocarbons, CFCs), on stratospheric ozone and climate are presently not well characterized." revised to "The potential impact of CCl₂FCF₃ (CFC-114a) and the recently observed CCl₂FCCl₂F (CFC-112), CCl₃CClF₂ (CFC-112a), and CCl₃CF₃ (CFC-113a) chlorofluorocarbons (CFCs) on stratospheric ozone and climate are presently not well characterized." Introduction: Inserted the following sentence: "Atmospheric measurements of CFC-114 are estimated to include a ~10% fraction due to CFC-114a (WMO, 2014). The atmospheric lifetime of CFC-114a is estimated to be similar to that of CFC-12, i.e., ~100 years (WMO, 2014)".

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Referee Comment: p.5.l 130: on what is this estimate based?

Author Response: The estimated uncertainty in the dilute mixture mixing ratios was based on the accuracy of the absolute pressure measurements. Due to the fact that numerous mixtures were used over the course of this study only an estimated uncertainty, which is relatively small and does not make a significant contribution to the overall cross section uncertainty, is given here.

Action Taken: The text has been revised as follows: "The dilute mixtures were prepared with an estimated accuracy of $\pm\sim 1\%$." was revised to "The dilute mixtures were prepared with an estimated accuracy of $\pm\sim 1\%$ (based on the estimated pressure measurement uncertainty)."

Referee Comment: p.6.l. 140: how wide are the individual wavelength bands?

Author Response: I believe that the reviewer is asking for the resolution of the UV absorption measurement. The resolution was ~ 1 nm.

Action Taken: The text in the first paragraph of section 2.1 was revised as follows: "The beam exiting the cell was focused onto the entrance slit (150 μ m) of a 0.25 m monochromator (~ 1 nm resolution) and detected using a photomultiplier tube (PMT)."

Referee Comment: p.7.l. 193: please indicate if the error estimates are from the paper by Bassandorj.

Author Response: The error estimates were taken from the preliminary 2015 JPL data evaluation, which is now publicly available.

Action Taken: A reference to the 2015 data evaluation has been added to the text for clarification.

Referee Comment: p.8.l219 ff.: to what extent does the uncertainty in actinic flux influence the lifetimes and their uncertainties? See also major point above.

Author Response: See response to first comment.

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Action Taken: See response to first comment.

Referee Comment: Conclusion: I suggest adding a short statement on the concentrations in the atmosphere and the global importance of these species.

Author Response: The atmospheric concentrations of the compounds included in this work is presented in the Introduction with the appropriate references. These compounds make a minor contribution to the total chlorine in the atmosphere, as pointed out in the Introduction, but it is important that the fate of these species are characterized by laboratory studies.

Action Taken: None

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