Reply to 'Comment on egusphere-2025-2861' by Anonymous Referee #1

Comments are copied in plain text.

Replies are given in blue.

Changes to manuscript are highlighted in green.

The authors discuss the trends, budget and deposition of TFA in Switzerland. The study is very comprehensive, including measurements of TFA in rainwater, rivers, lakes, modelling of the deposition of TFA from fluorinated gases, and estimated of TFA from pharmaceuticals and plant protection products. The paper has a good and extensive introduction of TFA. The methods, measurements and model calculations are described in great detail. The results are also described in detail with all their uncertainties and caveats. I want to compliment the authors with this paper, well done. I only have some smaller textual comments.

We would like to thank the referee for the positive response and compliments.

Some specifics comments on the text:

L9: Specify the region the deposition of 24.5 Mg applies to.

These totals were calculated for Switzerland. This was clarified in the revised manuscript.

L11-12: "In croplands … deposition". I suggest removing this sentence. Although interesting, it disrupts the flow of the abstract and is does not add relevant information for the remainder of the abstract.

We agree that the location for this information was not chosen carefully. However, we think that it is an important result especially in the light of the ongoing discussion of TFA in ground and drinking water. Hence, we somewhat rephrased the sentence and attached it to the previous statement concerning total TFA inputs for PPP and veterinary pharmaceuticals.

"In Switzerland, atmospheric (wet+dry) deposition amounted to 24.5+/- 9.6 Mg yr^{-1}, whereas TFA terrestrial inputs from the degradation of plant protection products (PPP) and veterinary pharmaceuticals in soils, estimated from the literature, ranged from 3.9 to 13.2 Mg yr^{-1}, depending on the assumption on degradation efficiency. TFA inputs from the degradation of PPP dominated 2-3 times over atmospheric deposition in Swiss croplands."

L12: It is not clear how old the "archived samples" are. Are they from the 1990s?

This information was given in section 2.1 but not repeated in the abstract. For clarification, we now added it to the abstract as well.

"Archived precipitation samples from the period 1986 to 2020 revealed that TFA …"

L17: You write about the risk assessment, but later in the paper you mention that there is no consensus of the risks of TFA (L81). I suggest you rephrase the sentence, e.g. "for refining the assessment of TFA sources for potential health and environmental risks.".

We would like to thank the referee for this suggestion and have largely adopted it.

"Additional environmental monitoring and source attribution studies are paramount for refining the assessment of TFA sources and levels for potential health and environmental risks"

L53-58: This a very long sentence and therefore hard to read. Please rephrase.

We agree that this sentence got a bit out of hand. We broke it up into two parts.

Due to their long atmospheric lifetime (order of years) and negative impact on global warming and/or the depletion of the ozone layer, national (e.g., EU Regulation on fluorinated greenhouse gases 2024/573 (European Parliament and Council, 2024), American Innovation & Manufacturing (AIM) Act of 2020 (Office of the Law Revision Counsel of the United States House of Representatives, 2020)) and international (Montreal Protocol) regulations are starting to target the emissive use of HCFCs and HFCs. Hence, a transition towards the use of HFOs with short atmospheric lifetimes (order of days to weeks) is ongoing.

L474: Data from WWTP could indeed be valuable, but are they a new source not accounted for yet? Do the WWTPs not discharge their water on the rivers?

Yes, WWTPs discharge into rivers and as such any TFA originating from them would be accounted for in the downstream observations. What we wanted to express is that right now, we are unable to distinguish this contribution to the total river flux exiting the country. Although inputs from atmospheric deposition and PPP degradation are mostly balanced by the outflow through the river systems, there may be additional sources (like WWTPs) and sinks to ground water formation that we did not quantify. Direct samples at individual WWTPs would help to further close the budget. We somewhat rephrased the paragraph to clarify.

There may still be considerable imbalance in the presented Swiss TFA budget, depending on the yield of PPP transformation, the assumption of a steady state of the fluxes within the 3 years of TFA observations and unaccounted inputs/sources and exports (e.g., groundwater formation). One previously suspected source is from communal or industrial WWTPs, which discharge into the river system but were not separately sampled in the current study. Thus, representative observations in WWTP discharge would be very valuable to improve the TFA budget and differentiate these from other unknown sources.

L657: "The gap in explained deposition…". Where the gap refers to is not clear from the previous sentences. Please add some text here.

This comment refers to L677 not L657. For clarification we added one more sentence defining which gap we were referring to.

The remainder of the observed atmospheric deposition (29-48 %) was not explained by the simulated degradation of known precursor compounds. This gap may be associated with unknown precursor compounds, underestimated TFA yields from known precursors, model shortcomings or a combination of these.

P30, table 2: There is a typo in the compound name: It should be HFC-43-10mee, not HFC-41-10mee

We would like to thank the reviewer for spotting this. It was corrected.