

Title: Projections of hydrofluorocarbon (HFC) emissions and the resulting global warming based on recent trends in observed abundances and current policies

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General comments

The authors have analyzed the trends in HFC emissions inferred from observations of atmospheric abundances and compare them with previous projections. The results indicate that as compared to the previous projections HFC consumption is lower in industrial and commercial refrigeration sector that is also supported by data reported by the developed countries and China. As a next step, a new HFC scenario is developed based on current trends in HFC use and current policies in several countries. Finally, impact on global surface warming is estimated in the new and several alternative scenarios.

The novel aspect of this study is that the authors have developed a new scenario for HFC emissions inferred from observations of atmospheric abundances and analyzed the warming impacts attributed to HFC emissions in the alternative scenarios as well. In my opinion, with an improved presentation this paper is acceptable for publication in ACP. I have few major and other minor comments to improve my understanding of the topic.

Major comments

1. P3, L64-65: You have mentioned that “HFCs do not deplete the ozone layer, but they are potent greenhouse gases contributing to climate warming.” Please note that HFCs do not destroy ozone directly, but they can indirectly lead ozone depletion through radiative impacts.
2. P4, L68-77: Based on this discussion what I understand is that the full compliance with the Kigali Amendment to the Montreal Protocol will avoid approximately 0.2 to 0.4°C additional warming by the end of this century. Please confirm!
3. P7, L196-199: There were regulations to limit the use of HFCs in place apart from the EU, USA and Japan. For e.g., the Swiss Regulation on Substances Stable in the Atmosphere, from December 2013, bans on many HFC uses, including larger air-conditioning, commercial and industrial refrigeration. Similarly, in Norway, a GWP-weighted excise duty on the import and production of HFCs and PFCs (including HFC-134a in mobile air-conditioning systems in imported cars), was introduced in 2003 and has steadily been increased since, its rate in 2015 was NOK354 (about €39) per tonne CO₂-eq. Similar regulations were in place in Australia (carbon tax), New Zealand (HFC levy) etc.
4. P7, L208: As I understand, heat pumps (ground, water and air) are not included in this analysis or merged with other sectors. Please confirm?
5. P9, L260-262: There are several alternative options available for a given sector. For example, NH₃ (GWP₁₀₀ = 0), HFOs (GWP₁₀₀ = <1), CO₂ (GWP₁₀₀ = 1) to HFC-32 (GWP₁₀₀ = 677). How do you settle on which low-GWP alternative will be selected to replace the amount of HFC consumption in the “current policy” scenario more than the limits of the Kigali Amendment?
6. P9, L268 (Table S1): How reliable are the reported leakage rates from the banks, particularly Russia? The leakage rates are lower in Russia as compared to EU. I do not see the leakage rates for the end-of-life emissions. As I understand, except EU and few industrialized countries not all the parties to the Montreal Protocol have good practices in place for the recovery of the refrigerants after the end-of life of the cooling equipment. How do you estimate the end-of-life emissions?
7. P9, L269: Why the GWP values provided in the latest IPCC/AR6 are not considered in this study?

8. P12, L367-368: HFC-410A (R-410A) is a zeotropic mixture of 50% HFC-32 and 50% HFC-125. It would be nice if you could rephrase “...(about 90% of HFC-32 and 63% of HFC-125 in 2017)...” indicating that this is not the composition of HFC-410A but the total consumption of HFC-32 and HFC-125 in stationary air-conditioning sector. One of the reasons of the high share of HFC-32 is that the split AC manufacturers are switching from high-GWP HFC-410A to low-GWP HFC-32 due to the existing national/regional and global (i.e., Kigali Amendment) regulations.
9. P14, L408: Why transport refrigeration is not shown in Figure 6? Is it included with others? This needs to be shown separately from the other small industrial sectors.
10. P14, L426: To be honest, I do not understand the purpose of these two hypothetical scenarios - Zero production and emissions scenario. What message they convey? What are the assumptions considered in this scenario? I think in the zero-production scenario you have considered the refrigerant bank in the equipment that will remain until the lifetime of the cooling system. Instead of zero production and emissions scenario what seems more realistic is an accelerated Kigali Amendment scenario. Also, avoid the repetition of the same results (in Section 3.7 and Section 4) on the contribution to the surface warming in these hypothetical scenarios.

Minor comments

1. P2, L44: Kigali controls or obligations/requirements?
2. P4, L93, Provide abbr. HCFC?
3. P4, L93, Provide abbr. UNEP?
4. P4, L94, Provide abbr. UNFCCC?
5. P4, L113, Please correct - ...Global Monitoring Laboratory (GML)...
6. P8, L233, Please correct - ...hydrofluoroolefin (i.e., HFO-1234yf)... as several other hydrofluoroolefin such as HFO-1234ze, HFO-1336mzz-E, HFO-1336mzz-Z, etc. are also being used in the market.
7. P12, L372-373: Provide reference – “about 43% of all HFC-134a consumption in developed countries was in this sector in 2017.”
8. P15, L462: Please rephrase ...(GWP₁₀₀ = 5080)...