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Comment on acp-2021-261

Anonymous Referee #1

Referee comment on "Evidence of a recent decline in UK emissions of hydrofluorocarbons determined by the InTEM inverse model and atmospheric measurements" by Alistair J. Manning et al., Atmos. Chem. Phys. Discuss., <https://doi.org/10.5194/acp-2021-261-RC1>, 2021

Comments on: Evidence of a recent decline in UK emissions of HFCs determined by the InTEM inverse model and atmospheric measurements, Manning et al., 2021, <https://doi.org/10.5194/acp-2021-261>

This paper describes results from an inverse model study of HFC emissions from the UK using the Numerical Atmospheric dispersion Modelling Environment (NAME) model incorporated into the Inversion Technique for Emissions Modelling (InTEM) model system. This study uses data from long-term monitoring sites at Mace Head, Ireland; Jungfraujoch, Switzerland; and Monte Cimone, Italy. In addition, the study incorporates recent measurements from Tacolneston (UK), Carnsore Point (Ireland), and Taunus (Germany) to better constrain UK emissions and provide higher spatial resolution. The authors found that total UK emissions of the HFCs studied were lower in 2019-2020 (expressed in CO₂-equivalent units) than in the previous decade. They also found that UK emissions based on top-down methods are about 30-50% lower than bottom-up, inventory-based emissions for several HFCs.

This work and the underlying methods provide important constraints and feedback on policy decisions related to reducing the consumption of HFCs in order to limit the climate impacts of these high-global-warming potential gases. This work should also help inform and possibly improve bottom-up inventory estimates of these gases.

General Comments:

The paper is well-written and the methods are well-established. I have only a few comments related to the work and presentation.

- On page 4, line 94, you say that you are applying an updated version of the InTEM model framework. Since models are updated occasionally, it would help the reader to know if the version of InTEM used in this study is the same as that described in Arnold et al (2018). If updates have been made since Arnold et al (2018), perhaps these could be summarized somewhere.
- The method of running the inversion in 1-yr and 2-yr blocks could use a bit more

explanation. Why is this done? Is this new or typical?

- On page 7, line 159, you discuss the use of a uniform prior emission field for HFC-23, and then later explain that you use 100% uncertainty on UK emissions in the prior for other gases. I would assume that a uniform (flat) prior would also lead to similar results for other gases (little dependence on the prior). Perhaps you can comment if that is indeed the case.
- In section 2.3 you refer to both "background" and "baseline" mole fractions. Are these the same thing? Or is "background" a model term and "baseline" a measurement term? It is a minor point, but these terms seem to be used interchangeably. And you also refer to background mole fractions as "the prior" (pg. 6, line 145). Not to be confused with the emissions "prior". Is there a better way to distinguish between these different things?

Specific Comments:

P 8, L194: "Time-varying background levels of mole fractions are required as prior information for InTEM for three stations: MHD, JFJ and CMN."

This implies that background mole fractions are not needed for the other stations (TAC, CSP, TOB). Is that the message you intended?

P 17, L280: "...however the growth in the Northern Hemisphere appears to have peaked in 2017 ..."

Given that the background mole fraction HFC-134a shows interannual variability, one could have also said the same thing in ~2006 and ~2013. So perhaps it is too soon to say? Still, I like figure 4 because it provides global context.

Sec. 3.2, HFC-134a: Perhaps a comment on COVID-19 is also applicable here. Is there any relation between HFC-134a emissions and vehicle miles driven? Could the lock-downs have played a role in 2020? Perhaps not, since 2019 emissions were also lower. It might also be relevant to mention when the EU began the transition to HFO alternatives to HFC-134a in mobile air conditioning.

Figure 6: The emission source maps for most HFCs shown seem closely related to population density, except for HFC-227ea, which shows a region of emissions in NW England that does not correspond to a large population center. And the correlation coefficients in Table S2 are smaller for some observing sites. Is this worth a comment, especially with respect to results from different years? Is that region of emissions in NW England an anomaly in 2019-2020?

Technical Corrections:

P, L15: remove "in the" after "decline in UK emissions". "... decline in UK emissions in the since 2018".

