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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Atmospheric observation-based global SF_6 emissions – comparison of top-down and bottom-up estimates" *by* I. Levin et al.

Anonymous Referee #2

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This study presents an analysis of high-precision atmospheric SF6 mole fraction observations taken over the past two decades at several locations across the globe. From the long-term records, their time derivatives, and the spatial gradient between two of the longest running sites the authors conclude that SF6 emissions are accelerating since 2005 following a decade long stable or declining emission total. A comparison with two bottom-up emission inventories shows a large difference between reported and estimated emissions. The reported emissions to the UNFCCC show least agreement with observations when used in a simulation of the atmospheric SF6 distribution, but cannot be falsified beyond the 1-sigma uncertainty of the transport model used. This paper shows the tremendous power and importance of global, calibrated, high-precision atmospheric monitoring and the insights that can be gained from this using relatively simple analysis techniques. The authors have succeeded in writing their story down in an accessible, credible, and attractive way and I recommend publication of this paper provided that two points of criticism are dealt with adequately in the final version.

(1) On page 26658 the authors state that the the latest EDGAR version has used some of the atmospheric mixing ratio information already to come up with emission totals, but to what extent is "not clear". This is very unsatisfactory given that this paper continues after that to compare EDGAR and UNFCCC emissions to atmospheric derived ones and hint at which product might better reflect the reality of the independent atmospheric approach. It seems to me that it would not be hard to provide the readers clarity on how much atmospheric information went into EDGAR4. A simple call to John van Aardenne at the Joint Research Center would probably suffice. I would like to see this issue resolved.

(2) In the comparison of simulated and observed SF6 distributions it is shown that the UNFCCC emission based values tend to underestimate the Alert-Neumayer gradient. Accounting for a 25% uncertainty in N-S exchange overcomes some of this deficit, and it is suggested that further sensitivity might lie in the N-S distributions of the assumed SF6 emissions with non-Annex I country emissions generally closer to the equator. I would like to know how large that sensitivity is, which one could calculate with some simple model runs. For instance, would the Alert-Neumayer gradient be simulated more accurately with the UNFCCC scenario if one did not assume all the non-reported emissions to be in non-annex I countries but also 10% in annex 1 countries themselves? Or even better: could one construct a scenario that divides the non-reported emissions between annex I and non annex I countries such that the emissions/GWH are more reasonable? How would that scenario do in Figure 3?

Further comments:

Title: The current title is a little bit hard to interpret as the words "atmospheric-based", "top-down" and "bottom-up" are not uniquely defined across research fields. I suggest to select a title that more strongly reflects the main message of the paper, as reflected best in the last sentence of the abstract.

abstract: I suggest to add a sentence on the disparity between emissions/GWH in the UNFCCC reported emissions, and use it to already in the abstract make a statement about the importance of long-term monitoring as a verification mechanism.

page 26661: Could you please add the inter-hemispheric exchange time of GRACE in the standard and 25% scenarios in units of yr-1.

Supplementary Material:

Section 3.3 describes a very detailed and complicated method to construct long-term time-latitude-altitude distributions of SF6 to estimate the global burden, as well as the growth rate. I can see why the burden (=emissions) needs to be estimated taking into account the latitudinal+tropospheric+stratospheric gradient. But for the emissions increase (=growth rate) one might take the more conventional method of taking the time derivative of a representative background site. How much does the third column of Table 1 in the main text deviate from a simple site-derived growth rate?

Did you consider comparing your derived vertical/time structure of SF6 to the available observations from the NOAA aircraft program that has collected many SF6 samples between 0-6 km since 2002?

In section 3.4 a comparison is shown between emissions (inverse growth rates) derived from several different networks/measurements of SF6. I have seen such a graph previously presented by Brad Hall from NOAA ESRL and was surprised to see the large spread in the temporal behavior of each network. For completeness, I would like to see the growth rate figures themselves for each network, with the NOAA ESRL record included in its entirety, i.e., flask and continuous records up to 2009.

Interactive comment on Atmos. Chem. Phys. Discuss., 9, 26653, 2009.

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Interactive Comment