

We thank Anonymous Referee # 2 for his valuable constructive comments and suggestions. Our specific responses are listed below in bold text.

Lines 78-88: This paragraph is an odd fit here since it includes too much detail. If the point is to quote the Patra et al. (1997) lifetime estimates then I would just include that with the Ray et al. and Kovacs et al. estimates in the prior paragraph. The profile shape and correlations with other tracers in the stratosphere aren't really relevant here since those details are well established and can be found in the cited references that derived the atmospheric lifetimes.

RESPONSE

We have edited and re-ordered this section as follows: -.

“Vertical profiles of SF₆ mixing ratios, collected from balloon flights up to an altitude of about 37 km, indicated that there is very little loss of SF₆ due to photochemistry in the troposphere and lower stratosphere (Harnish et al., 1996; Patra et al., (1997). Using an improved atmospheric-chemical-transport model (Patra et al., 2018) reported significantly older ‘age of air’ (AoA) in the stratosphere and Krol et al., (2018), based on a comparison of six global transport models showed that upper stratospheric AOA varied from 4-7 year among the models.

It has been suggested that SF₆ may have a shorter atmospheric lifetime ranging from 1937 ± 432 years (Patra et al.,1997), 580-1400 years (Ray et al., 2017) and 1120-1475 years (Kovács et al., 2017). However, these shorter, but still very long, SF₆ lifetimes would not significantly affect SF₆ emissions estimated from atmospheric trends (Engel and Rigby, 2019) .Given the very long lifetime of SF₆, compared to the period of our study, uncertainties in this term had a small influence on the outcome. For example, changing the lifetime from 3000 to 1000 years changed the derived emissions by around 1%, which is smaller than the derived uncertainties”.

Line 175: ‘through’ instead of ‘though’ and maybe spell out ‘five’ so a dash isn’t necessary before ‘core’.

RESPONSE

Thank you, corrected.

Line 329: ‘resolved’

RESPONSE

Corrected.

Lines 397-403: Are the large differences between the bottom up EDGAR and UNFCCC estimates easily explained? If so, it might be nice to include a brief statement on the reason(s) here.

RESPONSE

We have expanded the text on line 387 to address this point.

Our estimates are in close agreement through 2008 with the independent top-down estimates of Levin et al. (2010). Our estimates show similar trends to EDGAR v4.2, although our global total is on average 8.9% higher. It should be noted that the EDGAR

estimate includes some information from atmospheric observations (Rigby et al., 2010). On the other hand, it is likely that Annex-I countries are underreporting to the UNFCCC (Weiss and Prinn, 2011) and non-Annex-I countries are not required to report to UNFCCC which explains the much lower UNFCCC totals”.

Line 434: The values shown in Fig. 4 and Table 5 are actually the scaled emissions for all of China so that should be made clear here. As stated, it reads that the values shown are only for Eastern mainland China.

RESPONSE

Agreed. We have noted in Figure 4 and Table 5 that emissions are scaled emissions for all of China.

Lines 450-456: It seems like you’re referring to the same UNFCCC black symbols in these sentences so it reads a little awkward. Figure 4: I’m not sure if it’s just my version but the axes on this figure are barely visible.

RESPONSE

We have revised lines 448-453 to remove the duplication as follows: -

“Our bottom-up estimated emissions, using the high EFs, are generally larger than the bottom-up estimated China emissions determined by Fang et al., 2013, while China estimates based on the lower EFs suggested by Zhou et al. (2018) are much lower than the other Chinese emission estimates”.

Figure 4 axes have been darkened to improve visibility.

Line 503: It would be better to consistently refer to either FLITS or Urbino in the text and Figures 6 and 7.

RESPONSE

Agreed. FLITS has been used throughout.

Lines 511-512: ‘. . .emissions to the global total in 2018 was 3.1% (2.4-3.9%, Table 6, average of all inversions).’

RESPONSE

Thank you have added your revision.

Figure 8: The inset figure axes labels are so small they are difficult to read.

RESPONSE

Inset figure axes have been enlarged.

Line 659: add comma after ‘1978’

RESPONSE

Done

Line 672: remove comma before ‘countries’

RESPONSE

Done

Table 5: Should include the population scaling factor here even if it is also in the text.

RESPONSE

Agreed and added.