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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Hydrochlorofluorocarbon and hydrofluorocarbon emissions in East Asia determined by inverse modeling" *by* A. Stohl et al.

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We thank reviewer 1 for the comments on our paper, which will help us to further improve the paper. We repeat the reviewer comments below in italic fonts, followed by our responses in normal fonts.

1. P4 L124: How are the 'outliers' defined?

This is explained in Stohl et al. (2009). Outliers are, for instance, often associated with local pollution events that the model cannot resolve. We use the kurtosis K of the error frequency distribution to identify such large errors. For most stations, K is big if all errors are included. Therefore, we sorted out the largest absolute errors step by step until K of the remaining error values is below 5.

We have added a remark that further details can be found in Stohl et al. (2009).

2. P5 L136: In this current set-up (e.g. reference scenario as in 2.4), what is the magnitude of the negative emissions, and what is their percentage with respect to the non-negative ones?

This has also been discussed in more detail in Stohl et al. (2009). Negative emissions are reduced (details on how are also found in Stohl et al., 2009) until the remaining total negative emission is less than 3 per mille of the total positive emission, which is thought to be tolerable. Before the iterative removal, negative emissions are typically a few per cent but up to 10% of total emissions.

3. P6 L165: Could the authors explain how the inversion method will correct the errors introduced by using the consumption data?

Consumption data are used only when no reliable recent emission estimates are available. We have inserted the words "a priori" to make clear that the consumption data were used only for determining the a priori emissions. The errors are corrected just as any other errors in the a priori emissions are corrected by the inversion. There is no special treatment of errors due to the use of consumption data for defining the a priori.

4. P6 L185: Emissions due to import of foreign cars: why do the authors assume a third of the total emissions?

These emissions are not only due to the import of foreign cars but also other (limited) uses of HFC-134a in China. There are no actual data available to determine that fraction but it is clear that there will be extra emissions coming from these sources. The fraction is an expert best guess estimate by co-author D. Wan who was involved in the study of Hu et al. (2009). We have inserted the word "subjectively" before the word "assume" to make clear that this is a subjective estimate.

5. P6 L198: Emission flux uncertainties. Why do the authors choose these values (50% or 100% of the global mean emission flux)? How is the uncertainty of the prior

emission fluxes distributed?

This is a misunderstanding caused by our wording, which we have revised to make these values more clear. We assume every emission value to have an uncertainty of 50%, so the uncertainty is distributed just as the emissions are: Large emissions mean also large uncertainties. However, this would mean that in regions with low a priori emissions, the uncertainty is also low, thus tightly binding the inversion to the low (or even zero) a priori emission value. Thus, missing sources in the a priori inventory could not be identified by the inversion. Therefore, we set a minimum uncertainty of 100% of the global mean emission flux, which allows the inversion algorithm to make relatively large changes to the a priori even in grid cells with zero a priori emissions. The choice of the exact values of these uncertainties is, unfortunately, subjective as no uncertainty estimates of the emissions are available. If an emission inventory with appropriate error estimates were available, these uncertainties could be used in the inversion.

6. P7 Section 2.4: Uncertainties. The explanation of the 18 inversions would benefit from the introduction of a table.

That is a very good suggestion, which we have followed. The new Table 2 now provides such a summary. For your convenience, it is repeated here:

Table caption: Ensemble of 18 inversions used to quantify the uncertainty of the a posteriori emissions. "China/Japan" indicate whether the special information available for these countries was used ("Y"), or not ("N"). "Scaling" indicates how reference emissions have been scaled, and "Station removed" indicates which data set has been removed from the inversion.

Inversion number	China/Japan	Scaling	Station removed
1	Y	100%	-
2	N	100%	-
3	Y	50%	-
4	N	50%	-
5	Y	150%	-
6	N	150%	-
7	Y	100%	Gosan
8	N	100%	Gosan
9	Y	50%	Gosan
10	N	50%	Gosan
11	Y	150%	Gosan
12	N	150%	Gosan
13	Y	100%	Hateruma
14	N	100%	Hateruma
15	Y	50%	Hateruma
16	N	50%	Hateruma
17	Y	150%	Hateruma
18	N	150%	Hateruma

7. P8 L238: r_a^2 = 0:43: I don't think this one is a good correlation.

We have revised the original text: "Good correlation (r_a^2 =0.43, r_b^2 =0.63)..." to "Good correlation, especially for the a posteriori results (r_a^2 =0.43, r_b^2 =0.63)"

We agree that the a priori correlation is not really good but it is not bad either. It still means that 43% of the variance in the data can be explained by the model using the a priori emissions, and we would argue that the a posteriori correlation of 0.63 is indeed really good.

8. P8 L239: Do the authors have an explanation for the low correlation values obtained

for the Gosan site?

We do not have a good explanation and, thus, have not discussed this further in the paper. One reason may be that the Gosan station is closer to major pollution sources than Ochi-ishi and Hateruma. Thus, the model results may be more sensitive to modeling problems, for instance, errors in the simulation of the boundary layer heights around the station. The relatively coarse emission grid (resolution 1 degree or some 110 km) used may be problematic as well for Gosan, as the resolution may not be sufficient to resolve sources in the vicinity of the station.

Furthermore, there are a few dubious observed pollution events at Gosan which seem to be unrealistic but for which there is no indication at all of an actual measurement error. We have removed a few data points with excessively high measured concentrations but there may be other events which are not as extreme and have been overlooked. This issue is currently looked into and it is hoped that the model-measurement comparison can help identifying such events for closer inspection. Currently, however, the issue is unresolved and this may contribute to the lower correlations for Gosan. We would like to point out again that the events detected so far concern only a few data points (only some 15 suspicious values in total have been removed) and we do not believe that there are many more but this could still contribute to overall lower correlations for Gosan.

9. P10 L311: Robustness of the inversion results. Did the authors perform this analysis (e.g. retrieving emissions with sets of three stations) also for the national total emission of other East Asian Countries? Rather than robustness, I would say that the Chinese emissions can be well constrained by a combination of three out of the four stations used for the inversion. It would be very interesting to compare the sensitivities/footprint resulting by the different three stations groups and analyze their features. Have the authors already performed similar studies?

The inversion delivers results for all East Asian countries, so we have done three-

station inversions also for the other countries and they are, in fact, also part of the inversion ensemble used to quantify uncertainties. The new table 2, following your comment 6, should make this clear. However, we cannot discuss all the results in detail and so we have taken China as an example. We have plotted footprint emission sensitivities for every station separately and also for individual seasons but including these plots is out of the scope of the present paper.

10. P13 L420: 'automobile air conditioners account for two only thirds of total HFC-134a..'. Where is this estimate taken from?

This is explained in our response to your comment 4.

1. P4 L94: detecor-> detector?

Thanks, it is corrected.

2. Figures 3 and 4: the inclusion of the major cities location would be helpful for the discussions in section 3.2 (Emission patterns).

We believe these figures would become too busy if city locations are labeled, especially since the inversion produces small-scale features often exactly where those major cities are located. These interesting features would then be hidden below the labels.

3. P10 L338: b -> a

Thanks, it is corrected.

Interactive comment on Atmos. Chem. Phys. Discuss., 10, 2089, 2010.