**Atmospheric
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Discussions**

Interactive
Comment

Interactive comment on "A new analytical inversion method for determining regional and global emissions of greenhouse gases: sensitivity studies and application to halocarbons" *by* A. Stohl et al.

A. Stohl et al.

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We thank reviewer 2 for the thorough review of our paper. Below, we have repeated specific points in italics, followed by our responses in upright font shape.

In the conclusion, the differences between the inventories and the posterior emissions for Europe and China are explained by a time-lag between comsuption and emissions. Other studies limit their interpretation of the disagreement due to large uncertainties (Prinn et al., 2000). Yokouchi et al., 2006 show similar values for HCFC-22 in China (50 kt/year) but +/- 34 kt/year using also the Hateruma station in Asia. More arguments should be included to justify this conclusion, or some realistic assumptions that

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could explain this time-lag as long as the posterior uncertainty is not available with the present system.

Notice that for HFC-22 we have not used country-based emission data but only consumption data. HFC-22 is used in refrigeration and as a foam-blowing agent, so it seems logical to us that there should indeed be a time-lag between the time of consumption and the time of emission to the atmosphere. The fact that our a posteriori results suggest such a time-lag both for Europe where emissions decrease with time and for China were emissions increase with time can be considered as encouraging results. As suggested by reviewer 1, one might introduce a time shift of the emissions relative to the time of consumption even in the a priori. However, without a priori information on this time shift, we have refrained from doing so.

In the method, the positive definiteness allows you to get rid of negative fluxes. However, the iterative algorithm leads to include a part of the transport model error into the flux error. The present recalculation at each step could attribute some inconsistencies in the system and so in the retrieved fluxes. At the first step, the correction of some pixels are due to transport error. The positive definiteness will balance the correction to the other pixels (included in the same SRR or response function). Could you discuss this point more clearly in the paper.

This is of course true, though one should not believe (or give the impression) that results would be worse than withouth eliminating the negative values. On the contrary, the total amount per country would probably be worse if we would skip the removal of negative values, as balancing negatives may occur outside the country.

The title of the paper implies the description of a "new" inverse system whereas the different elements were previously used in other studies, as Yokouchi et al., 2006 for the baseline component, and Eckhardt et al., 2007, 2008, for the negative flux adaptation. Offsets are often used for other gases when the variability arised from long term and short term components.

We agree that most components of the inversion scheme have been used before and have therefore changed the title to "An analytical inversion method for determining regional and global emissions of greenhouse gases: Sensitivity studies and application to halocarbons".

19065-14: Could you precise the % for Europe and China.

We have added the numbers for North America (-9%, 23%, 17%, respectively) and Europe (11%, 11%, -4%, respectively).

19067-16: Explain "4-10d".

We have rewritten this statement to make it clearer. It now reads: "Over the short time intervals (about 4-10 d) typically covered by back trajectories, halocarbons are almost perfectly conserved. Thus, such methods are little affected by uncertainties in a substance's atmospheric lifetime."

19067-28: You demonstrate later that prior information has not a large impact on your posterior estimate. If the constraint is sufficient (large number of observations), high resolution prior wouldn't be required. Could you rephrase the sentence that is too general.

We do not really demonstrate that prior information has no large impact on our estimates. For instance, in the extreme case where a priori emissions were set to zero, the results were quite different from our standard case with realistic a priori emissions. But the reviewer is right that this depends on the number of observations available. Therefore, we have added the remark "especially when the number of observations is small" to the sentence "In general, using a priori information allows higher resolution in the inversion result".

19068-14: The choice of 20 day backward plumes is not clear. Could you explain better.

This point was also raised by Reviewer 1 and is discussed in our response to reviewer

1.

19073-10: Same question for 31 day backward plumes.

This point was also raised by Reviewer 1 and is discussed in our response to reviewer 1.

19076-9: The part y2 is also described by the transport simulation (31d backward transport).

No. We hope to have explained this better now in the revised version of the manuscript (see responses to previous two points). The 31 d (which are the length of the baseline segments, not the backward transport duration!) are more or less arbitrary and could be shorter or longer than the 20 d duration of the backward simulation. Shorter intervals mean that the baseline will be determined at higher temporal resolution but at the cost of an increased number of unknowns in the inversion. Since the total number of observations is limited, the number of unknowns (i.e., emission boxes plus baseline values) needs to be limited, too. The 31 d allow an approximately monthly construction of the baseline – hence the choice of 31 d – and facilitate construction of seasonal variations but still allow the majority of unknowns to be used for the emission boxes.

19078-3: Despite the lack of information on prior flux uncertainties, less documented countries should be less constrained than countries in the UNFCCC database. Could you justify you assumption not to distinguish documented and not documented countries.

The reviewer is right that uncertainties in the emissions will vary from country to country and probably, at least in relative terms, are larger for countries not listed in the UNFCCC database. However, since we have set the minimum uncertainty to be the global average emission flux, the **relative** uncertainty is actually largest in areas where absolute emission fluxes are low, i.e., in most non-UNFCCC countries. A more refined error specification would require more information on the distribution and uncertainty

of the emissions in all countries, which is not available to us.

19081-18: "Highly accurate" can't be demonstrated by a pseudo data experiment. Capacity of the system can be evaluated but not its accuracy.

We agree and have removed the second part of the sentence mentioning accuracy. It now reads: "This shows that the inversion algorithm has been set up correctly."

19084-13: Figure 1 doesn't show the constraint on the East coast by the european stations. A regional estimate would be more clear.

By plotting emission sensitivity fields for individual stations, we have verified that our statement is correct. Figure 1 does show that the European stations create a region of high sensitivity that stretches out into the North Atlantic and towards North America and is at least suggesting that the sensitivity over the east coast of North America is mostly due to the European stations. To really show this convincingly to the reader would require another figure and we don't think this point is important enough to justify that. However, instead of referring only to Fig. 1, we now write: " (as indicated in Fig. 1 and confirmed by emission sensitivity fields for individual stations [not shown])".

19086-28: Figure 7 :: Could you explain the increase of negative events in the time serie compared to the a priori.

This is due to the lower a posteriori than a priori emissions, leading to fewer over- and more underestimates. Overall, however, the error is reduced substantially. Notice also that there are actually quite many negative events that have decreased in magnitude. The eye tends to concentrate on the few events that became more negative because the a posteriori line is plotted over the a priori line.

19096-9: "help" instead of "aide".

Changed as suggested.

Interactive comment on Atmos. Chem. Phys. Discuss., 8, 19063, 2008.

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