

## ***Interactive comment on “An extended Kalman-filter for regional scale inverse emission estimation” by D. Brunner et al.***

### **Anonymous Referee #3**

Received and published: 20 December 2011

This is a good manuscript that is also well-written. I very much enjoyed reading it. There are several aspects that I particularly like. First, as someone without much background in inverse modeling, I find the tutorial nature and the detailed equations very beneficial. It was also good to show the behavior of the technique to simulated data in depth before discussing the results for the HFC observations. The sensitivity analysis was also very enlightening. Overall, it is a very educational and convincing paper. I believe that it should be published after the comments of the reviewers are addressed.

I have one general comment and then some specific one. The specific ones are primarily as points of clarification.

General comment: I would like some more general statements about how this work fits

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in with previous papers that have tried to infer emissions and how much further we still have to go. I would like a better feeling of where we are in our ability to infer estimates from country- and continental-scale regions. You state how big interannual emission changes must be to “see”, but with your analysis can you provide a better general feeling of how much we should believe the country specific and European estimates that you have provided? Are we to the point now where we should believe your estimates more than the reported ones? As you rightly point out in the introduction, emissions estimates may become important to validate a future climate agreement. Can we do that now using your approach? Is it just a matter of a higher density of observation locations?

I realize some of these answers cannot be answered by your current work, but any general summary information you can provide along these lines could be very helpful to those not directly in the inverse modeling field, but who want to use the results.

Specific comments and minor comments: For the minor comments below, my wording suggestions are just that. Feel free to use other wording that is better. Page, line 29196, 18 – change to “higher and lower than reported emissions in different countries” 29196, 21 – replace “ban” with “controls in developed countries”. Ban implies a complete phaseout, which has not yet occurred.

29198, 12-15 – since technology has already changed, consider rewording to “Without further regulation, their continued growth in the atmosphere led to a non-negligible contribution to radiative forcing equivalent to 7-12% of the radiative forcing of CO<sub>2</sub> by the year 2050 in a scenario in which it was assumed that developing countries replace HCFCs in the same manner as developed countries have.” or something to this effect. 29198, 18 – ozone assessments have used 1- and 12-box models as well to infer emissions. 29198, 22 – clarify whether you mean all these studies or just the 3-D ones 29198, 26 – replace ‘lain down in’ with ‘provided by’ or ‘contributed by’ 29198, 27 – change ‘data’ to ‘dataset’

29199, 26 – add “(“ before “Keller”

29201, 12 – change ‘as fire extinguisher’ to ‘in fire extinguishing equipment’ 29201, 14 – insert ‘a’ before ‘solvent’

29203, 12 – replace ‘angles’ with ‘directions’

29205, 18 – I would like a little more explanation about the separation between the emissions contribution and the background. For example, you could say a little here about what contributes to the background. Also, clarify what you mean by assuming persistence for the emissions. Clearly emissions change over time for the various grid boxes. How is that consistent with the assumption of no change in emissions from time  $t-1$  to time  $t$ . What time frame is the derivative of the background assumed to be fixed?

29210, 26 – change ‘10%’ to ‘10th’

29212, 26 – since North America is out of your domain, how does the inversion deal with this? The episodes would be too abrupt to be dealt with by the background term, wouldn’t they be?

29214, 20 – clarify whether just temporally correlated or also spatially

29214, 19-22 – how would the answers have differed if the noise were added to the measurements (at the 2 or 3 sites) themselves? If you have not done this, this would be another important aspect of the problem, in order to understand the importance of imperfect observations at Mace Head and Jungfraujoch.

29215, 6-29 – it might be helpful to have a figure that shows the spatial pattern of the retrieved emissions for one of the cases that doesn’t work quite so well. With total RMS numbers, it is not possible to tell whether there is a systematic spatial pattern to the error. For example, are the errors largest where the emissions are largest? If a single pattern cannot be representative, perhaps some text could provide some more detailed information. 29215, 12 – remove ‘a’ before ‘Gaussian’ 29215, 14 – insert ‘the’ before ‘case’

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29216, 7-10 – this a very important, well-made point. It is mentioned in the conclusions, but it might be worth giving a bit more emphasis in the conclusions. 29216, 17 – add ‘s’ to ‘emission’

29217, 9-11 – it is hard to evaluate the comparison in this figure. Other options would be to show one curve and then another of the difference (percent or absolute), or keep the current figure and then include one shorter time period in an expansion inset. I leave it to the authors’ judgment to determine the best approach. 29217, 15-16 – I do not see any discussion of the correlation numbers “with background” that are shown in the figure. 29217, 26 – I do not recall reading whether these are 1-sigma or 2-sigma error bars.

29218, 14-16 – does this statement mean that there are plants in this part of France that manufacture HCFC-141b, and we just don’t know how much they emit? Please clarify.

29218, 22-24 – can you provide an explanation of why this occurred?

29219, 4-7 – I find this statement confusing. If it is accurate, some additional explanation about the retrieval outside the European domain would be very helpful. Specifically, why do Southern Hemisphere values matter to your retrieval? 29219, 6-7 – I am also confused by this sentence. Doesn’t it either reproduce the variability, or it doesn’t because it attaches a large uncertainty. But it doesn’t reproduce the variability by assigning a large uncertainty does it? 29219, 9-11 – quantify the size of the effect on emissions. Also, perhaps add more explanation about implications for conclusions. It seems this could be an important sensitivity.

29219, 24-26 – can you add error bars to the increases? Otherwise, we cannot tell if the inversion estimates are consistent with the reported values or not.

29220, 13-18 – this section needs clarification because it initially seems you are talking about a comparison with the Manning estimates. 29220, 20-22 – but shouldn’t this sen-

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sitivity be reflected in the size of the error bar? In that case, there should be agreement within the error, or twice the error bar.

29221, 4 – this could be read as Italy reports 0 emissions. Perhaps removing ‘any’ would help? The wording in the abstract and conclusions is clear.

29223, 8-11 and general about entire section 4.1 – after reading this and the comment about the land-sea mask on Italy, I am left wondering how accurate the Italian estimates really are. Some additional discussion seems needed here, particularly to convince the reader that the 15-20% value for your ability to infer country emission estimates is accurate. Also, do you expect similar impacts for -152a and -141b for all these sensitivity cases. 29223, 27 – change ‘much’ to ‘many’

29224, 6 – perhaps consider adding ‘arising from our implementation of the FLEXPART model’ or something similar to the end of the sentence. 29224, 21-23 – this information would be useful in section 4.1

29226, 11 – I believe this range arises from the 15% in the end of section 3.2. The range should be given there to be consistent with the conclusions. If it is not this straightforward, more explanation of the 15-20% range should be given before the conclusions. 29226, 22 – ‘ban’ – same comment as for abstract

29236 – make clear that cases 1-7 are synthetic and the HFC cases are ‘real’ in the caption. This helps if one looks at the table without reading through the corresponding text.

29248 – in the top 4 panels, the lowest 2 values are both 0.01. I know why, but you may wish to change it so the bottom number is 0.007.

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Interactive comment on Atmos. Chem. Phys. Discuss., 11, 29195, 2011.

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