**Atmospheric
Measurement
Techniques
Discussions**

Interactive
Comment

Interactive comment on "Observation of strato-mesospheric CO above Kiruna with ground-based microwave radiometry – retrieval and satellite comparison" *by* C. G. Hoffmann et al.

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1 General remarks

This paper describes measurements of CO in the middle atmosphere made with a ground-based microwave radiometer. The general principles of this type of measurement have been known for many years but the technicalities of making a reliable and consistent measurement remain challenging. Also, few if any data have been published for CO at high latitudes as measured with this technique.

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The paper goes on to compare the measurements to several datasets from satellite-based instruments. Twenty years ago this sort of comparison would have been re-garded as valuable validation for the satellite data but the satellite datasets used here have (mostly) been validated against each other and agree as well with each other as they do with the ground-based instrument. So the tables are turned somewhat, with the satellites providing validation for the ground-based instrument. That is important, though, as a ground-based instrument can (in theory) be kept running indefinitely. How-ever, once MLS, MIPAS, SABER and ACE-FTS stop working there will be no satellite instruments left making measurements of middle-atmosphere chemistry, nor are there any planned beyond the very early stages of development, from where they may be very easily cancelled or delayed.

The paper is generally well written and well organised and should be published subject to the corrections below being made. The standard of written English is generally good, but there are occasional oddities. I have listed some of these below, concentrating particularly on cases where the sense is not clear. But I have not corrected everything in this respect as it gets to a point where the right wording becomes a matter of opinion.

2 Specific comments

- Page 4217 line 15: In a sense it is a good idea to use SABER temperatures as these are probably the best temperature data that you can get for the upper stratosphere and mesosphere. But what happens when SABER ceases operat-ing? Is it, for example, possible for an instrument like KIMRA to produce its own temperature profiles from an oxygen line, as microwave limb sounders do? If not, what other options are there? This might be important in an era in which MLS and SABER have ceased operations and no other satellite instrument has been flown that could act as a replacement. The authors might want to discuss this at some point in the paper.

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- Page 4218 line 14: The words "certain standing waves" are a reference to one of the main technical problems with microwave radiometers and I rather feel that this paper sweeps the issue under the carpet. How many standing waves? What are their amplitudes and wavelengths? What would they look like when plotted on Figure 2? Have the waves already been removed from the top panel of Figure 2?

- Page 4219 and Figure 2: It would be useful to add $F(\mathbf{x}_a)$ to the upper panel, in addition to $\mathbf{y}$ and $F(\hat{\mathbf{x}})$, in order to give the reader some impression of how much change in the calculated spectrum is caused by the fitting process.

- Page 4228 and Figure 7: It might improve Figure 7 if the retrieved VMR profile was also shown, so that the reader can get an impression of how big the errors are compared to the VMR values.

- Page 4230 and Figure 9: In order to give the reader an impression of how well the instrument tracks the seasonal changes (or at least, whether it tracks the changes in the same way as another instrument) it might be worth plotting the collocated MLS data in the same format as Figure 9. I show a first cut at such a plot in figure 1 of this comment. The authors are better-placed than I am to produce a matching pair of figures but it is neverthess clear that many atmospheric features are seen by both instruments. (The vertical scale used in Figure 1 of this comment is $z^* = 16\,\mathrm{km} \times (3 - \log_{10}(p))$ where p is the pressure in hPa.)

- Page 4233 lines 23ff: For MLS the authors reference Pumphrey et al. (2007), which documents MLS data version 2.2. As the authors have (correctly) used the more recent MLS data version 3.3 they should also reference the V3 data quality document (http://mls.jpl.nasa.gov/data/v3-3_data_quality_document.pdf) as this documents the differences between MLS V2.2 and MLS V3.3. For MIPAS the authors should spell out for the reader that the data used are those produced by IMK (http://www.imk-asf.kit.edu/english/sat.php) and not those produced by the team at Oxford (http://www.atm.ox.ac.uk/group/mipas).

- Page 4239 lines 10-12: It should be made clear that "variations of the retrieved profile" means variations with time and not variations with altitude etc.

3 Technical corrections

- Page 4210, line 8: I do not think that optimal estimation requires capital letters.

- Page 4211 line 10: "west wind" should probably be replaced with "westerly wind"

- Page 4211 line 20: "approx." should be "approximately"

- Page 4212 line 25: Delete the word "already".

- Page 4214 line 13: Replace "principal" with "principle".

- Page 4215 line 11: I would delete "so-called". To most native-English speakers, a "so-called" forward model implies that people sometimes erroneously call it a "forward model" but the proper name for the thing is something else. (The Oxford English Dictionary notes that "so-called" has both the pejorative usage I note above and the non-pejorative sense used by the authors of the present paper. The OED states that the non-pejorative usage tends to occur in technical contexts and is analogous to similar constructions in Dutch and German. My opinion is that "so-called" should be avoided in English language scientific papers as it is liable to be mis-interpreted.)

- Page 4215 line 22: Delete the comma after "fact".

- Page 4216 equation 2: This appears to me to be presented in an unnecessarily confusing way. In fact, either I am confused by it or it is not correct. The expression is actually

$$(\mathbf{y} - F(\mathbf{x}))^T \mathbf{S}_e^{-1}(\mathbf{y} - F(\mathbf{x})) + (\mathbf{x} - \mathbf{x}_a)^T \mathbf{S}_a^{-1}(\mathbf{x} - \mathbf{x}_a)$$

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(Equation 5.3 in Rogers (2000)) and I think that it is more easily understood when presented as such.

- Page 4216 line 6: Again, I would not use "so-called".

- Page 4216 line 17: Remove comma after "both"

- Page 4217 line 9: Remove the word "for".

- Page 4219/4254, Figure 2: The text "Sensitive Range" on the figure is very small compared to the other text. The authors should be careful to make a copy of the final figure at the intended final width (1-column or 2-column as appropriate) and then confirm that all the text in the figures is of a similar size to the caption text in AMT. Much larger than this looks silly, much smaller is hard to read. Figure 2 will currently *either* have the text "Sensitive Range" unreadably small *or* will have all of the other text on the figure too large. It would be wise to make the same check on the other figures as well.

- Page 4223 line 20: replace "get" with "become".

- Page 4228 lines 23-24: I think I know what this sentence means but it is not very clearly expressed. It should be clarified.

- Page 4229 and Figure 8: The top panel of the figure has a lot of lines in it which are hard to distinguish from each other. I do not have a good suggestion for fixing this, but the authors should make some effort to design a figure that is easier to interpret.

- Page 4229 and Figure 9: When making contour plots of CO with height as one axis I think that you really need to use contours that are spaced like a log scale, so that they go something like

$$\cdots 0.1, \ 0.2, \ 0.5, \ 1, \ 2, \ 5, \ 10, \ 20, \ 50, \cdots$$

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The authors have made some attempt to achieve a similar effect by squeezing the interesting part of the colour scale down to the bottom but it still draws too much attention to the green band between 5 and 10 ppmv and may be hiding detail in the large orange region. I have used a scale of the sort I recommend in Figure 1 of this comment although I have spoiled the effect rather by attempting to make my colours be vaguely similar to those used by the authors.

- Page 4231 line 8: remove comma after "both".

- Page 4231 line 21: Replace "the ones" with "those".

- Figures 10 and 12: As with Figure 8, these figures contain a lot of lines which are hard to distinguish from each other. The authors should consider what they can do to make these figures easier to interpret.

Interactive comment on Atmos. Meas. Tech. Discuss., 4, 4209, 2011.
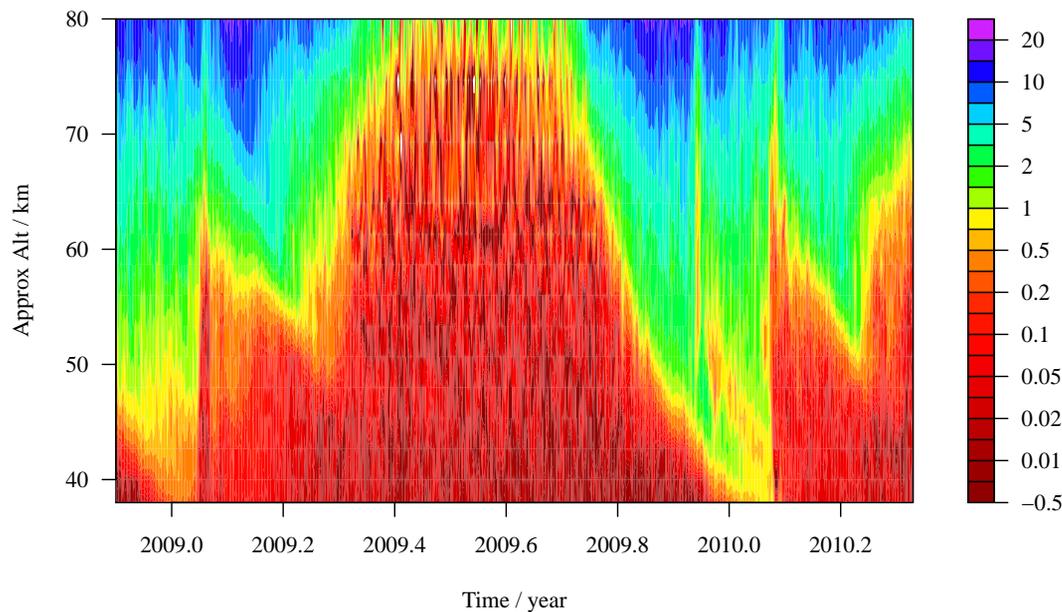
Fig. 1. Time series of MLS CO in a 5 degree latitude by 24 degree longitude region centred on Kiruna.