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Atmospheric Chemistry and Physics Discussions

Interactive comment on "CO measurements from the ACE-FTS satellite instrument: data analysis and validation using ground-based, airborne and spaceborne observations" *by* C. Clerbaux et al.

C. Clerbaux et al.

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Dear Reviewer 3,

Thank you for the useful and constructive comments.

Detailed comments: P3, line 21: Also SCIAMACHY is measuring in absorption

SCIAMACHY is quoted as recommended now.

Figure 1: In the figure caption it is said that the profile below 6km is constructed from TES observations. What is the vertical sensitivity of TES? I have some doubts that it can really yield information for surface near layers? Figure 1: In the figure it is indicated that for TIR nadir the sensitivity range is from 0 – 20km. Maybe one should

better write 2-20km or something similar? TIR instruments are usually not sensitive to layers close to the surface.

Figure 1 just aims to provide a standard and realistic profile in order to quick visualize the vertical range covered by the different validation means used in this validation paper. The vertical sensitivity of TES is indeed limited. But nadir looking thermal infrared instruments can be sensitive to the 0-2 km altitude level in case of high thermal contrast, as demonstrated in Clerbaux et al, GRL 35, L03817, doi:10.1029/2007GL032300, 2008.

Fig. 3: maybe the size of the Figure should be narrowed in x-direction?

Figure 3 was modified as recommended.

Fig. 4, 5, 6: over which altitude range are the data actually averaged?

The data are not vertically averaged. The altitude is 7.5 km for Figure 4, 16.5 km for Figure 5 and 49.5 km and 59.5 km for Figure 6a and b. These values are quoted in the Figure captions.

Fig. 4, 5: What do the crosses indicate? The location of the instrument or that of the tangent height?

Yes, crosses indicated tangent heights. It is now specified in the captions.

Page 7, line 7: it is said that the CO profile ‘should’ be smoothed. This vague statement leaves it uncertain to the reader what is actually done in this paper. I suggest to mention in which cases a ‘smoothing’ was applied and in which cases not.

This was done every time we received the averaging kernel functions along with the CO validation measurements (it turned out to be not possible for the Cervinia MW observations).The modified sentence is now: ...the CO profile of the instrument with the higher profiling capability is smoothed by convolution with the averaging kernel

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functions of the instrument with the lowest vertical sensitivity.

Table 3: Explain DOFS in the title of the table or below; what does it mean if no DOFS value is given?

As some groups were not able to provide DOFS values, these are now removed from Table 3 for a sake of consistency.

Table 3: I think the altitude range of MOPITT and TES does not reach down to 0km?

Thermal infrared instruments can be sensitive to the lower layers during daytime and at locations where the thermal contrast (temperature gradient) between the surface and lower atmosphere is significant (see Clerbaux et al. GRL, 2008).

Page 9, line 5: The statement ‘is better than a column’ is misleading. Actually, MOPITT can not measure the true total column, because it lacks sensitivity for layer directly above the surface. Often in this altitudes, the highest CO concentrations occur.

OK. This paragraph was modified as following to make it clearer: As the other thermal infrared instruments, MOPITT generally lacks sensitivity near the surface except during daytime and at locations where the thermal contrast (temperature gradient) between the surface and lower atmosphere is significant.

Page 11, line 6: Maybe step 1 should be combined with step 5

True. But in fact step 5 was applied afterwards when we were trying to explain discrepancies.

Page 11, line 9: Step 3 and 4 should be interchanged?

OK, step 3 and 4 are now interchanged.

Fig. 10: For the comparison of partial columns it is not clear to me what was actually done to the two data sets. This should be explained in more detail. I suppose that the

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ACE profiles are first convoluted with the averaging kernels of the GB instruments, and then they are integrated between two altitudes (lower altitude given by the lowest ACE data point; highest level given by the upper range of the GB data?

Yes. The caption of Figure 10 was improved to better explain this. For the partial column comparison: the ACE-FTS CO partial columns were calculated after treatment of the profiles with the GB averaging kernel functions (except for the Cervinia station, for which these functions are not available). Each ground-based station plotted in Figure 10 is identified by a different color code (see legend) and each partial column is obtained by integration of the CO concentration from the lowest available ACE-FTS level (typically 6.5 to 8.5 km) to the altitude indicated in Table 3.

(are these altitudes constantor changing for each pair of data?)

Yes, the lower (ACE-FTS) altitude can change for each pair of data.

For the GB data it is not clear to me which partial column or total column is taken?

As for ACE-FTS, for GB each partial column is obtained by integration of the CO concentration from the lowest available ACE-FTS level (typically 6.5 to 8.5 km) to the altitude indicated in Table 3.

Which relative profile is taken for the integration of partial columns? Density profiles were obtained by interpolating of ECMWF temperature and pressure fields to match the time and location of each measurement.

My feeling here is that in specific cases large errors can occur, e.g. if high CO concentrations close to the ground appear. In these cases, the GB instrument will ‘see’ these high concentrations, but ACE won’t. Consequently, the GB data should be much larger. Could this effect explain part of the observed scatter?

This is true but the smoothing by the averaging kernel functions should limit this effect. Most of the scatter seem to be due to the fact that the spatial and temporal coincidences

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are sometimes not good.

What does it mean that the treatment with averaging kernels is performed ‘when available’? What is done if not available?

The Cervinia station uses a retrieval method that does not provide averaging kernel functions, and hence these data were not smoothed.The caption was corrected to say this more explicitely.

Fig. 11: what causes the gap between 21.5 and 23.5km?

CO negative values. We replaced the plot to show this explicitly.

Fig. 12, 13: Was there no convolution applied? And why?

Because of the very different vertical altitudes covered by MOZAIC and ACE, applying averaging kernel was found to difficult if not impossible.

Page 13,line 20: Better replace ‘good’ with something else, e.g. ‘small’

Done.

Page 13, line 17: I suggest to compare only partial columns, like for the GB instruments. The profiles shown in Fig. 14 indicate a vertical resolution which is much better than in reality. How is the relative profile shape of the TES measurements determined?

We started with the comparison of profiles also for ground based instruments. It was hard to find an integrated way to summarize the information about the agreement/disagreement, so we decided to gather all the results as partial columns.

For nadir-looking instruments (TES and MOPITT) we did compare the products as they are provided by each mission, although the vertical resolution is limited. The relative profile shape of the TES measurements are determined by the a priori.

Page 15, line 4: Was a convolution with averaging kernels performed for MLS?

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Interactive Comment

No, as the MLS vertical resolution is close to that of ACE.

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