**Atmospheric
Chemistry
and Physics
Discussions**

Interactive comment on "Using ground-based solar and lunar infrared spectroscopy to study the diurnal trend of carbon monoxide in the Mexico City boundary layer" *by* W. Stremme et al.

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Final response:

We are thankful for the critical observations and especially the constructive suggestions made by both referees and used these to improve the quality of the manuscript. The answers to the comments of the referees are answered in separate files for each referee; here we just want to respond to the main critic, which relates to a general comment from referee 2 that (a) we do not exploit the potential of the measurements and (b) focus more on a quantity (MLH) whose meaning is unclear.

The measured CO column is highly variable due to the many processes mentioned in the manuscript, and so a more complete exploitation would needs a statistical analysis based on a longer time series. The ability to reconstruct from two CO measurements a quantity which seems to be almost independent on the actual pollution and which has typically the same pattern, is shown in this work. It is demonstrated that one can understand very well one part of the processes which control the vertical CO distribution. Nevertheless, we did some additional work to satisfy the two mentioned points above and this additional work, which was initiated by the referee comments, improved the results considerably.

(a) The correlation between the measured CO column and the wind speed provides an insight as to in which phases of the day either horizontal or vertical transport affects the CO dispersion. Filtering the data with wind speed helped improve the correlation and a section was added to describe the results: "Diurnal and nocturnal behavior of the CO column.

(b) The meaning and importance of the MLH or PBLH is confirmed by recent studies which claim that these quantities lead to differences between model and measurements in Mexico City (Tie et al, 2009 ACP, same special issue), and its relevance to our work was mentioned by referee 1)). In addition, the comparison of the reconstructed MLH-FTIR and the MLH-model obtained from the NARR allows portioning the freshly emitted CO amount from a residual amount. This was achieved by following a suggestion from referee 2 and the extended model used for calculating MLH-FTIR is included in the revised manuscript (added subsection).

Update to technical improvements in the retrieval settings:

Additionally, we have done three improvements in the manuscript which were not directly addressing referee comments. These changes reflect current work done

in the group and do not affect the results nor the conclusions in the original manuscript.

1. Updated dataset:

Te retrieval set-up was updated for total CO column determination resulting in slightly better results. The new retrieval-settings differ only by the simulation of the Instrumental Line Shape (ILS) and the data was reanalyzed and included in the new manuscript. Parts of the section 4.3 about the ILS-error, which had been underestimated before, had to be rewritten. The new retrieval shows a slightly better spectral fit (smaller residuals) and more measurements now passes the quality control, so that we could include 62 days instead of the 50 used in the analysis during the same period (October 2007 to February 2008). In the new dataset the systematic difference seen between November and February and pointed out by referee #1 is no longer apparent. The systematic difference between the old and new version of the retrieval (0.4×10^{18} molec/cm^2) is comparably small with respect to the typical variability in each day of around 4×10^{18} molec/cm^2. Also, the mean value for total CO column at the UNAM and Altzomoni sites changed from 3.2×10^{18} molec/cm^2 to 2.8×10^{18} molec/cm^2 and 1.2×10^{18} molec/cm^2 to 8.4×10^{17} molec/cm^2, respectively.

2. Improved evaluation experiment:

Since the column amount was reduced systematically by about 25% for all solar zenith angles, another control experiment with a gas cell was performed under improved conditions to evaluate which retrieval reflects the true CO column better. The new retrieval version agrees much better, and we observe a total systematic difference between the true CO column (injected CO to the cell) and the retrieved CO column of 10 %. This measured total systematic error is larger than that reported originally and we have to admit that the estimation of an error around 4 % due to uncertainties in the ILS underestimated the systematic error. None of the results and conclusions

presented had to be modified as the results and errors were systematically updated for both the Mexico City and Altzomoni. The reconstructed MLH shows the same behavior and grows in the same range as can be seen in the figures. Parts of the section 4.5 were changed accordingly describing the new evaluation experiment done on 24 February 2009 at the UNAM site.

3. Adding of data of a second Campaign (2008) in Altzomoni

Additionally, as stated in the response document for referee #2, we have added the data from a second campaign in Altzomoni, which took place during 15 to 18 November 2008, to confirm the representativity of the background CO column used.