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Atmospheric Measurement Techniques Discussions

# *Interactive comment on* "Ground-based remote sensing of $O_3$ by high and medium resolution FTIR spectrometers over the Mexico City basin" *by* Eddy F. Plaza-Medina et al.

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General Comments

This paper presents for the first time the time series of the vertical profiles and total column amounts of one of the most important gases on the atmospheric chemistry, ozone (O3), for Latin America. The strategic location of the ground-based stations used and the methodology proposed, using high-resolution and medium-resolution Fourier Transform infrared (FTIR) solar absorption spectra, provide high confidence to the results obtained. Especially interesting is the presentation of an improved tropospheric ozone product from the combination of two remote sensing FTIRs data, which allows for a better monitoring of tropospheric ozone concentrations. The paper is well-written



and concise. Thereby, I suggest this paper may be suitable for publication after addressing the specific comments listed below.

Specific Comments

Section 2: Ground-based FTIR remote sensing

a) The authors mention that the microwindows used to retrieve the O3 concentrations are the same windows as presented in Schneider and Hase (2008), but this is not strictly true. Schneider and Hase (2008) suggest a broad microwindow between 1000 and 1005 cm-1, which has been split into two microwindows in the current work. I guess that the authors did this to avoid the interference of water vapour (H2O). If so, please clarify in the text. Also, the authors include the 1005-1006cm$-$1 microwindow, not present in Schneider and Hase (2008). So, I think it would be more appropriate to say that the selection of the O3 microwindows is based on Schneider and Hase (2008) and clarify why the authors modify the original microwindows.

b) The error budgets clearly show that the atmospheric temperature profile is an important error source for Altzomoni and UNAM FTIRs as well as for the combined product. Simultaneous temperature retrieval with O3 profile has widely demonstrated that improves theoretically and experimentally the quality of the FTIR O3 products (e.g. Schneider and Hase, 2008, Schneider et al., 2008, García et al., 2012). Have the authors considered performing this temperature retrieval? Why not?

c) The authors have assumed the same error in the ILS for both FTIRs (5% for the modulation efficiency and 0.1 rad for the phase error). But, as for the measurement noise, I guess that the ILS's error of the medium-resolution FTIR should be a bit higher than the high-resolution one. Also, the ILS's errors could explain in part the large systematic/statistical errors observed in the combined product. Why the authors use the same value? Why the authors do not consider the ILS as a possible explanation for the large errors found in the combined product? Could the authors show a plot with the time series of the ILS for each station? What is the frequency of the cell measurements at each station?

d) How the layers that are detected by each FTIR are defined? Are the consecutive levels added until a DOF of one? There is a high signal in the UNAM averaging kernels at about 35 km, what is the reason?

Section 3: Free tropospheric and stratospheric O3

a) I am wondering if smoothing the Atlzamoni averaging kernels with the UNAM ones makes sense when the difference of the total DOFs is only of one. Would it be more appropriate to estimate the altitudes that are well comparable analyzing the square root of the diagonal of Scmp as presented in Wiegele et al. (2014) and then compare the original volume mixing ratios? How are the correlations shown in Fig. 7 for the not-smoothing data?

b) The authors use the works of Thompson et al. (2008) and Emmons et al. (2010) to explain in part the observed O3 annual cycle of the free troposphere. These works point out the importance of the transport of the urban emissions on the free tropospheric O3 levels. But, according to the authors in page 7, line 32, "the Altzomoni solar absorption spectra are only very weakly affected by the polluted boundary layer". So, I find both statements contradictory, but maybe I am missing something. Have the authors considered that the maxima in spring-summer could indicate the importance of photochemical production of tropospheric ozone?

c) The O3 annual cycles at Altzomoni are compared with other NDACC stations such as Izaña or Jungfraujoch. But, there is another NDACC site at equal latitude and about the same altitude, Mauna Loa. Have the authors compared the Altzomoni and Mauna Loa FTIR O3 products? This could be a very nice cross-validation of the Altzomoni O3 data, especially for the stratospheric values.

d) The authors estimate the Scmp to filter out the data using a value of 10% for the whole range of altitudes. But, this threefold could be altitude-dependent as suggested



in Fig. 7, where a worse correlation is observed for the upper level. Plots showing the Scomp vs correlation and the profiles of the square root of the diagonal of Scmp could help to analyze better the comparability of the two remote sensing instruments. See comment a) related to use the Scmp only for filtering the data and not to look for the altitudes for direct comparison.

Section 4: Boundary layer

a)The theoretical error budget for the combined product is not in agreement with the experimental comparison (higher statistical errors and lower systematic ones). Also, in the abstract the authors mention that the combined products offer theoretically and experimentally better results. This is true for the sensitivity, but not for the error estimation shown, which could cause some confusion to the readers. The authors provide some causes to account for these discrepancies, but they have considered re-doing the error estimations with more realistic values. For example, is it enough to assume 5% and 0.1 rad for the ILS errors when the UNAM ILS is assumed as ideal?

b) As the authors stated, the combined product is very promising. I am interested in other possible applications of this product. Could it be used the other way round, ie, to reduce the tropospheric signal in the Atlzomoni ULTS data? Or to improve the tropospheric sensitivity of space-based sensors such as IASI?

Technical Comments Page 5, line 12. Please include reference for the WACCM model-version 6. Page 7, line 14. Replace "in temperature" by "temperature". Page 10, line 8. Replace "subtropical" by "sub-tropical". Page 12, line 5. Replace "in situ" by "in-situ". Page 16, line 11. Replace "Eq. 10" by "Eq.(10)".

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