

Interactive comment on “Climatology of pure Tropospheric profiles and column contents of ozone and carbon monoxide using MOZAIC in the mid-northern latitudes (24 N to 50 N) from 1994 to 2009” by R. M. Zbinden et al.

Anonymous Referee #1

Received and published: 19 August 2013

The major objective of this manuscript is to derive a tropospheric climatology of ozone and carbon monoxide profiles over a staggering 15 years of data from the MOZAIC program. The most important addition to previous work by the same author is the characterization of the unsampled troposphere. The method is simple, using a provisional climatology and linear interpolation as necessary, but performs well against an independent data set. The authors then go on to explore the features in the columns, profiles, and partial columns over the various MOZAIC locations and further show comparisons to satellite observations making for a very interesting read. I am pleased that

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the authors have made this dataset publicly available and think it will be very useful to the atmospheric science community at large.

My only major concern is the number of grammatical errors in the paper. I found some sections of the paper very difficult to read and may have misinterpreted the intent of the authors as a result. I have highlighted some of this in the grammatical errors section below, but this list is by no means complete. I recommend further editorial proofreading if possible.

Beyond this, I only have minor corrections/suggestions after which I judge that this paper would be suitable for publication. Below, I have separated actual comments from purely grammatical corrections.

Minor Comments & Suggestions

By using the ozone and CO datasets from MOZAIC, the authors are able to use the correlation between ozone and CO to diagnose the impact of different processes or air mass origin. However, to my knowledge, the NO_x data has also been available since 2001. The ability to pin down upper tropospheric enhancements of NO_x comes to mind as potentially useful additional information in the interpretation.

While there are over 40,000 aircraft profiles used in the climatology presented in the paper, some of the sites are severely undersampled as the authors point out. In particular, I wonder about the statistical significance of the seasonal cycle and the danger of overinterpretation at Los Angeles and think the discussion about this site could be scaled back greatly.

Page 14700, Line 18: How sensitive are the results to the choice of a 2 PVU cutoff for the tropopause and how easily would it be to offer an alternate dataset with say a change in the lapse rate instead? From a model comparison perspective, it may be difficult to compare with a pure tropospheric climatology from MOZAIC if there are differences in how the tropopause is defined.

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Page 14703, Line 4: Please list the number of coincident profiles and for what subset of the years the MOZAIC/WOUDC comparison is made. What is the precision of the WOUDC measurement? Is there no coincident measurement that you could use to also validate the impact of Mfit on CO?

Page 14709, Line 21: Please list the satellite retrieval versions used in the studies. For example, the instrumental drift for MOPITT has been corrected in the latest version of the retrieval (Deeter et al., 2013).

Page 14710, Line 13: If the July bump is from a particularly intense biomass burning year in North America, why is there no interannual variability (as reflected by the box and whiskers) for July in Figure 6 for USEast?

Page 14711, Line 28: Why is there a March minimum in Beijing when a spring peak is seen at Japan? Note that 'exceeding the Japanese one' at the top of page 14712 is imprecise as I read it to imply that there was also a March minimum at Japan when I think you mean that it exceeds the Japanese minimum when it occurs in August.

Page 14713, Line 7: Could this higher ozone in the BL be associated with the large biogenic emissions in the southern US during August-September?

Page 14719, Line 8: Please note the version of the satellite retrievals in the description. Explain how the correspondence criterion is chosen between the satellite and MOZAIC data. As the authors later note, these comparisons are not truly one-to-one.

Page 14720, Line 4: TES does not truly provide vertically-resolved information - note the degrees of freedom for signal (DOFS) is usually ~ 2 . If you are using TES for ozone, why not also use CO? This is outside of the scope of this paper, but it would be interesting to see if the satellite retrievals are able to capture the MOZAIC ozone-CO correlations (see Zhang et al. (2006) and Voulgarakis et al. (2011)).

Page 14738: Could you explain in the text what you mean by the grey shaded rectangle in Figure 2 and the definition of Mclim and Wclim. Change 'underlined' to 'shown.'

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Page 14739: In Figure 3, please show the fit statistics inset.

Page 14741: With mean in Figure 5, do you mean median?

Suggestions for Fixing Grammar in the Manuscript (no need for a response):

Page 14698, Line 2: Add 'the' before MOZAIC/IAGOS

Page 14698, Line 18: Capitalize MOZAIC

Page 14699, Line 10: Make the range cited [119 W – 140 E] here and in the abstract consistent

Page 14699, Line 22: Add 'a' before in a previous study

Page 14700, Line 26: Add 'is' before the entire troposphere

Page 14701, Line 2: Define s in TP(X, z, s) before this

Page 14701, Line 8: Change best-fitted to best-fit

Page 14701, Lines 16 and 19: Fix the bracket for the altitude ranges,]

Page 14701, Line 24: Change till to until

Page 14703, Lines 6-7: Changed 'noted' to 'denoted'

Page 14703, Line 23: Fix the bracket for the altitude range,]

Page 14704, Line 6: Add 'at all sites' after $r > 0.9$.

Page 14704, Line 10: Change 'as' to and

Page 14705, Line 7: Add 'MOZAIC' before pure tropospheric ozone column

Page 14705, Line 25: Change 'all over' to 'over all'

Page 14706, Line 5: Change 15 yr to 15 yrs

Page 14706, Line 8: Add 'a' before box

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Page 14706, Line 21: The zDT variability is the weakest among all sites, or just the European sites?

Page 14707, Line 15: What is meant by the 180 ppbv in the parentheses? Is maximum supposed to be mean here?

Page 14709, Line 13: Remove 'with' before 'its high level of pollution'

Page 14709, Line 15: Remove 'the' before Fig. 6

Page 14709, Line 16: Change 'profiles/months' to 'profiles/month'

Page 14710, Line 13: Add a space between 'westerly' and 'winds'

Page 14710, Line 24: Add 'the' before southern Pacific.

Page 14711, Line 4: Remove 'emission' after 'remote fires'

Page 14711, Line 9: Change 'experimented' to 'evaluated.' Specify that they were comparing to a model using the assimilated SCIAMACHY data and name the model.

Page 14711, Line 10: For 'smallest contribution of local CO emissions,' what is this relative to?

Page 14711, Line 15: Add 'into' before 'account the extremely large'

Page 14711, Line 15: Add 'which' before 'we estimated to be'

Page 14711, Line 19: Remove 'the' before 'CO'

Page 14711, Line 20: Change 'as more consistent' to 'to be more consistent'

Page 14712, Line 16: Add 'the' before 'origin of the two'

Page 14713, Line 5: Define LiNOx as lightning NOx

Page 14713, Line 22: Change 'maximum of the all study' to 'maximum of all sites in the study' or equivalent.

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Page 14713, Line 26: Specify that the O3 excess in the troposphere is relative to other European sites.

Page 14713, Line 28: Do you mean the east coast of the US?

Page 14714, Line 3: Change 'Bassin's' to Basin

Page 14714, Line 12: Use of 'than usual' is very casual use of language and imprecise. Do you mean relative specifically to Middle Eastern sites or all northern mid-latitude sites?

Page 14714, Line 13 – 14: Add 'range' after 2-15 and 0-2 km

Page 14714, Line 18: Do you mean Uaemi?

Page 14714, Line 21: Replace 'on the evidence of the' to 'evidence of a'

Page 14714, Line 26: Add 'on' before 'the MOZAIC summer profiles'

Page 14714, Line 27: Change 'on both' to 'at both'

Page 14715, Line 5: What is this 'negative O3 anomaly' relative to?

Page 14715, Line 6: Change 'to high level' to 'with high levels'

Page 14715, Line 9: Change (Liu et al., 2001) to Liu et al. (2001)

Page 14715, Line 27: Change 'process' to 'the processes'

Page 14716, Lines 15 and 27: I suggest changing 'regime' to 'mechanism'

Page 14717, Lines 8: Change 'on the Fig.' to 'in Fig'

Page 14718, Line 18: Add 'the' before 'monsoon in'

Page 14718, Line 25: Add 'and' before 'is obviously linked'

Page 14718, Line 26: Change 'and the O3' to 'or the O3'

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Page 14720, Line 10: Add 'a' before 'larger winter,' change 'are visible' to 'is visible'

Page 14720, Line 14: Change 'by adding the averaging kernel?' to 'with the averaging kernel applied'

Page 14721, Line 10: Change 'th' to 'the'

Page 14723, Line 3: Change 'excepted' to 'except'

Page 14724, Line 2: Change 'overage' to 'average'

Page 14724, Line 10: 'Last outcome highlight' to 'The last outcome highlights'

Page 14725, Line 6: Change 'adressed' to 'addressed'

Page 14725, Line 6: Change 'for to the European Commission' to 'to the European Commission for'

Page 14725, Line 10: Add 'the' before 'data base'

Page 14737: In Figure 1 caption, change 'explanations' to 'explanation'

Page 14742: Change 'specific' in the Figure 6 caption to 'different'

References:

Deeter, M. N., S. Martínez-Alonso, D. P. Edwards, L. K. Emmons, J. C. Gille, H. M. Worden, J. V. Pittman, B. C. Daube, and S. C. Wofsy (2013), Validation of MOPITT Version 5 thermal-infrared, near-infrared, and multispectral carbon monoxide profile retrievals for 2000–2011, *J. Geophys. Res. Atmos.*, 118, doi:10.1002/jgrd.50272.

McMillan, W. W., Evans, K. D., Barnet, C. D., Maddy, E., Sachse, G. W., and Disken, G. S.: Validating the AIRS Version 5 CO retrieval with DACOM in situ measurements during INTEX-A and -B, *IEEE T. Geosci. Remote*, 49(7), 2802-2813, doi:10.1109/TGRS.2011.2106505, 2011.

Voulgarakis, A., Telford, P. J., Aghedo, A. M., Braesicke, P., Faluvegi, G., Abraham, N.

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L., Bowman, K. W., Pyle, J. A., and Shindell, D. T.: Global multi-year O₃-CO correlation patterns from models and TES satellite observations, *Atmos. Chem. Phys.*, 11, 5819-5838, doi:10.5194/acp-10-2491-2010, 2010.

Zhang, L., Jacob, D. J., Bowman, K. W., Logan, J. A., Turquety, S., Hudman, R. C., Li, Q., Beer, R., Worden, H. M., Worden, J. R., Rinsland, C. P., Kulawik, S. S., Lampel, M. C., Shephard, M. W., Fisher, B. M., Eldering, A., and Avery, M. A.: Ozone-CO correlations determined by the TES satellite instrument in continental outflow regions, *Geophys. Res. Lett.*, 33, L18804, doi:10.1029/2006GL026399, 2006.

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