

Interactive comment on “Profiling of formaldehyde, glyoxal, methylglyoxal, and CO over the Amazon: Normalised excess mixing ratios and related emission factors in biomass burning plumes” by Flora Kluge et al.

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The reviewers comments are written in **bold**, our responses are marked with AC (authors comments).

We are very grateful to the reviewer for his comments and overall very positive assessment of our manuscript, to which we react in the following way.

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Comments:

ACPD

Line 10: The authors have not yet introduced RGF or RMF, and unless readers are already familiar with the chemical formulas for glyoxal and methylglyoxal, this may be confusing. I suggest either noting the names of the species in Line 1, or defining RGF and RMF here.

AC: We agree and have changed lines 1-4 to: “We report on airborne measurements of tropospheric mixing ratios and vertical profiles of formaldehyde (CH_2O), glyoxal ($\text{C}_2\text{H}_2\text{O}_2$), methylglyoxal and higher carbonyls ($\text{C}_3\text{H}_4\text{O}_2^*$) (see below), and carbon monoxide (CO) over the Amazon Basin during the ACRIDICON-CHUVA campaign from the German High Altitude and Long-range research aircraft (HALO) in fall 2014.” Additionally, in lines 10 and 12 has been added: “The mean glyoxal to formaldehyde ratio R_{GF} . . . The mean methylglyoxal to formaldehyde ratio R_{MF} . . .”

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Line 29: The authors state that these compounds are emitted, but much of the paper discusses their formation mechanism, so I would change “emitted” to “emitted or formed”.

AC: Line 30 has been rephrased to: “Among the manifold of species emitted in large amounts by fires or formed in their plumes are carbonyl compounds. . .”

Line 52: The line “glyoxal and methylglyoxal are formed by 47% and 79%, respectively” is slightly confusing. Does this mean 47% of the glyoxal is formed from isoprene? Or 47% of the isoprene that reacts forms glyoxal?

AC: Yes, 47% of the total atmospheric glyoxal is formed from isoprene oxidation. To clarify this, the sentence in lines 54-55 has been changed to: “Similar to formaldehyde, large parts of the atmospheric glyoxal (47%) and methylglyoxal (79%) are thought to be formed during the oxidation of isoprene emitted by vegetation (Fu et al., 2008, Wennberg et al., 2018).”

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Line 57: Rather than citing “GEOS-Chem model simulations” for the lifetime, I would cite the papers that get that figure, such as Fu 2008

AC: The text has been rephrased accordingly.

Line 93: No comma needed after “They concluded”

AC: The comma has been erased.

Line 97: If the authors want to mention the A-train, include a brief description of what that is. Otherwise, it does not seem necessary to include that information.

AC: In lines 99-100, the sentence has been changed to: “More recently, (Stavrakou et al., 2016) examined emissions of crop residue fires in the North China Plain using data from the OMI satellite.”

Line 112: German should be capitalized

AC: German has been capitalized.

Table 1: “Temperature” is misspelled

AC: The typo has been corrected accordingly.

Line 172 or later: It’s not clear how the [C₂H₂O₂] and [C₃H₄O₂⁺] concentrations are derived from the mini-DOAS remote sensing measurement. Are they derived from the ODLimb line-of-sight measurement? Do we interpret that as the instantaneous concentration at the altitude of the aircraft? Particularly later, when the total column measurements are compared to the satellite measurements, it would be helpful to have that distinction made.

AC: Yes, we use the line-of-sight limb measurement of target and scaling gas to derive mixing ratios of the target gas for the altitude range of the aircraft, from where most of

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the absorption comes from. This is quantified by the so-called α -factors, which give the fraction of the absorption in altitude layer z_i relative to the total atmospheric absorption. They are derived from our DOAS measurement (SCD_X) and radiative transfer modelling of the respective Box air mass factors (B_{X_i}):

$$\alpha_j = \frac{\left(SCD_X - \sum_{i \neq j} [X]_i B_{X_i} z_i \right)}{SCD_X} \quad (1)$$

To clarify this aspect, lines 155-157 have been rephrased to: “From the mini-DOAS limb measurements of the total slant column density, the concentration $[X]_j$ of the trace gas X in the atmospheric layer j (i.e., the altitude of the aircraft) is then determined from...”

Additionally, we have added in lines 163-165: “When needed, the total atmospheric column density of the respective gases is approximated by integrating the measured lower and higher quartile profiles in incremental steps of 100m each (fig. 9).”

Line 175-181: Use the terms ODlimb and ODms instead of b and c for more clarity.

AC: The text has been rephrased accordingly.

Figures 2 and 3: The various shapes of blue are hard to differentiate, and the markers are too small to really see the shapes.

AC: The colors of the curves in fig. 2 and 3 have been changed accordingly (see attachment).

Figure 5: What time are the MODIS satellite images from? Beginnings of the flight? The panels numbers a-d are missing

AC: Panel numbers have been added within the figure panels (see attachment). The time of each MODIS satellite image has been added to the figure caption: “The MODIS

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satellite images are from 14:10 UTC (Sept. 11, 2014), 14:30 UTC (Sept. 16, 2014), 14:20 UTC (Sept. 18, 2014), and 17:55 UTC (Sept. 19, 2014). The images were taken from NASA WORLDVIEW <https://worldview.earthdata.nasa.gov/>.”

Figure 9: It is very difficult to see the “C-shape” curve in the CO data that the authors discuss. Consider putting the x-axis on a log scale.

AC: The axis scaling has been changed accordingly (see attachment) and we have added in the figure caption: “Note the logarithmic scale of the x-axis in panel a.”

Line 376: To remain consistent with the rest of the paper, use ppb instead of nmol/mol

AC: The text has been rephrased accordingly.

Line 357: “leading to their generally correlated vertical profiles”. Later on, the authors state that the formaldehyde vertical profile is markedly different from the other two. Clarify this?

AC: For clarification, line 371-372 has been changed to: “As their dominant source, isoprene globally accounts for 67%, 47%, and 79% of the annual sources of formaldehyde, glyoxal, and methylglyoxal (Fu et al., 2008), respectively, leading to their rapidly decreasing vertical profiles.”

Figure 11: In the x-axis label, put which satellite(s) were used in each of the other papers.

AC: The figure has been changed accordingly (see attachment).

Line 420: Are the emission ratios from the column integrated value or the concentration value?

AC: The emission ratios are derived from the inferred mixing ratios. For clarification,

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line 440 has been changed to: “Instead, we use the inferred mixing ratios...”

Line 440: “Emissions of monoterpenes, like alpha-pinene, on the other hand, are at least one order of magnitude smaller”. This statement is unclear. Smaller than what?

AC: This compares the emissions of monoterpenes to those of isoprene (which dominate). Accordingly, line 461 has been changed to: “Apparently, emissions of monoterpenes, like alpha-pinene, are at least one order of magnitude smaller than isoprene emissions.”

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