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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Anthropogenic VOC in Abidjan, southern West Africa: from source quantification to atmospheric impacts" *by* Pamela Dominutti et al.

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Response to the reviewer's comments We would like to thank the reviewers for their mindful comments on the paper. We have worked hard to comply with all of them. The whole manuscript has been improved, and several changes were introduced in the material and methods, results and discussion and quality of the figures. In the following, the comments made by the referees appear in black, while our replies are in green, and the proposed modified text in the manuscript is in blue.

Anonymous Referee #1 Received and published: 2 February 2019 This paper presents an analysis of "up to 56 VOC" measurements made in Abidjan, Côte d'Ivoire at different

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ambient sites comprised of different emissions sources using sorbent tubes analyzed on a laboratory GC-FID and GC-MS. This paper is part of the DACCIWA (Dynamics-Aerosol-Chemistry-Cloud Interactions in West Africa) program. Much of the source analysis has already been published in Keita et al., 2018(https://www.atmos-chem-phys.net/18/7691/2018/), including the source measurement work using sorbent tubes and emission factor calculations for a number of stationary and mobile sources, and I found the line between the previous paper and this paper was very blurred and made it so this paper feels like less of a standalone paper, and more of an addendum to the previous work.

The data presented in Keita et al 2018 was obtained under the same work package of the DACCIWA project. In Keita et al.'s paper, only the emission factors of 15 VOC data were described among with particle emission factors. The quantification of VOC emissions was only focused on the road transport sector. In this new paper, the VOC dataset is extended to 56 VOCs including Intermediate Volatile Organic Compounds which were not included in Keita's paper. The measurements not only include emission factors but also ambient mixing ratios in Abidjan. Finally the analysis presents the variability of ambient concentrations, the analysis of the emission factors, the estimation of VOC anthropogenic emissions for all source sectors (not only road transport) from this extended dataset and the evaluation of the atmospheric impacts of the emissions on the regional chemistry.

The authors report emission ratios based on measurements made at several different locations in Abidjan meant to correspond with previously-reported source emission factors. It is difficult to fully understand the measurement analysis, however, as the information given in the paper regarding the sampling strategy was very general, and due to a data embargo, no data were made available for the manuscript discussion period. Presumably this data will be made available prior to the finalization of this paper, but I do not feel I can properly assess the paper without more details about the measurements.

The material and methods section improved are more details are provided for a better understanding of the sampling strategy. Regarding the availability of the data and end of the embargo, currently, all the project data on Sedoo has been moved to a CC-BY license. Since the DACCIWA project did not fully finance VOC data, we have requested their availability in the project website, and they will be soon publicly available.

The ambient campaigns were conducted during the dry season (February 2016). Samples were collected every 2 days at different times of the day (from 6 a.m. to 8 p.m.) by using a manual pump (Accuro 2000, Dräger) at 100 mL sccm flow rate. One single sorbent tube was exposed six times at each sampling location. In total, 3.6 L of air were collected at each site for a single 600 mL-volume each time.

My primary issue with this paper, however, is that there are a very large number of errors in typography, grammar and inappropriate word choice such that I find the message of the paper is lost due to these errors. Many of the errors should have been caught by a careful reading and some small attention to detail. I include below some of the basic comments that I have noted, as well as a short list of the technical notes that I made in the first handful of pages and for the figures and tables, but I regret that I am unable to fully assess the science of the paper while these errors exist. For this reason, I recommend that this paper be rewritten and then resubmitted once these typographical, syntax, grammatical, and English language errors are corrected. Please note that the comments and technical notes listed below are by no means a comprehensive list of the issues with the manuscript, as my role is reviewer and not copy editor. I would be happy to review the paper again once it is carefully checked for the above errors and resubmitted.

We thank the reviewer for all the comments and suggestions. The paper was thoroughly revised by a native speaker and sections have been rewrote for a better understanding of the reader.

General comments: Page 3, line 95: The authors are describing the “main differences.

. . associated with the emission source estimations. . .", but are ambiguous about what they're comparing. Are the differences between the inventories and the measurements? Or between inventories? Be specific. Also, the inventory or inventories need to be properly described when they're first discussed.

We have improved the manuscript quality and the discussion about comparisons.

The sampling strategy for the ambient VOC measurements is not explained well. The authors state that the sampling took place for one month, during which "samples were collected once a week at different daytime." They go on to explain that active sampling of VOCs using a manual pump was carried out on sorbent cartridges. . . exposed several times a week at each site which corresponds to a total volume of 600 mL. Does this mean that one single cartridge was brought back to the same site and exposed several times over the course of a week or a month? Or was it analyzed between each sampling? Is this described elsewhere? Please detail exactly how many times and at what times of day each cartridge was sampled give a schematic of the sampling mechanism and sampling strategy.

Thank you for this valuable remark. The methodology section was rewrote including the details here request.

The ambient campaigns were conducted during the dry season (February 2016). Samples were collected every 2 days at different times of the day (from 6 a.m. to 8 p.m.) by using a manual pump (Accuro 2000, Dräger) at 100 mL sccm flow rate. One single sorbent tube was exposed six times at each sampling location. In total, 3.6 L of air were collected at each site for a single 600 mL-volume each time.

In general, I would prefer the places where ambient sampling took place to be referred to as "sampling locations", rather than "sampling points."

The text was changed as suggested.

Considering the availability of comprehensive VOC measurement capabilities, it seems

inappropriate to suggest that the measurement of 56 VOCs is “extensive”, although it is impressive. I just recommend avoiding hyperbole. Further, I do not have the ability to assess the extensiveness of the measurements, because the data are not yet publicly available. This seems out of step with current practices, which generally state that ideally the data for publications be available in an independently-managed DOI. At the very least, the data should be made available at the time of submission.

We agree with the reviewer that extensive is not the more appropriate word. We have changed it by extended dataset.

Lines 349-350: I fail to see how the authors came to this conclusion. There is a lack of information about the proximity of each sampling location to any nearby sources, wind speed and wind direction data, sampling times, etc., and so much of this feels very arbitrary. As well, "the commonalities in spatial distribution seem to be also related..."this is very hand-wavy. Without some regional dispersion modeling detailing the sources, the authors seem to be jumping to conclusions that are not backed up by their measurements or careful analysis.

We thank the reviewer for this suggestion. The results were reanalysed, and the discussion was changed taking into account the reviewer‘s comments.

Technical Notes:

Page 1, line 21: define VOC Page 1, line 24: Indicate “and later analyzed in a laboratory. . .”, not “the laboratory”. Page 1, line 25: when describing “two-wheelers” in the abstract, please specify that these are two-stroke or four-stroke motorized two-wheelers. Page 1, line 32: overpassing is likely not the right word here. Page 1, line 33: insert “organic” into “secondary aerosol formation.” Page 1, line 33: define POCP. Page 1, line 36: “at the national level” Page 2, line 40: “For only Côte d’Ivoire. . .” Page 2, line 41: “the whole of Europe” Page 2, line 42: “sectors for Côte d’Ivoire, there is. . .” Page 2, lines 45-46: rather than “essential sources”, perhaps “widespread” or “ubiquitous”? Page 2, line 51: “The Western Africa region. . .” Page 2, line 61: “. . . from

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remote sources, i.e., aerosol dust from. . .” Page 2, line 62: “biomass burning plumes and local urban. . .” Page 2, line 63: “. . . campaign showed that air quality. . .” Page 3, line 87: “. . . quantify their emission sources (e.g., Bechara et al., . . .) – this list is not a comprehensive list of all the field campaigns to quantify the VOC in the atmosphere, but rather a small subset of examples. Page 3, line 94: “for global scales and involve numerous. . .” Page 3, line 99: “. . . inventories commonly estimate (not report?) the total mass of VOCs. Page 3, line 101: this sentence needs to be reworded for clarity. Page 3, line 105: “by a factor of 50. . .” – for what species or group of species? Be specific. Page 3, line 110: “their impact on human {what?} and air quality conditions.” Page 4, line 116: “construction of a regional emission. . .” Page 4, line 119: “operation as much as possible. . .” Page 4, line 126: “sources is assessed (?) regarding. . . and secondary pollutant formation.” Page 4, line 136: “Health,” Page 4, line 143: replace susceptible with “responsible?” or another more appropriate word. Page 4: line 143: replace combine with “include”? Page 5, line 163: delete the space in “(Keita” – there are many places throughout the paper where spaces are either present or absent in this kind of way. Also: line 167; line 330; line 342; line 426; Figure 1 caption; Figure 2 caption; Figure 3 caption.

Also throughout: 1) in units, remove decimals (i.e., mL.minËĘ-1 should be mL minËĘ-1) 2) ppmv and ppbv – the v should not be subscripted. And define ppmv and ppbv (parts per million by volume, parts per billion by volume.) Page 5, line 172: “Secondly, ambient VOC measurements. . .” Page 5, line 175: The selection of sampling locations (not points) were also identified to compare with the emission sources previously measured.

Page 5, 179: “at different times of day.” Page 5: 189: “were performed and analysed. . .” Line 287: "in Table SM1, in the..." Line 295: there are no coordinates in the plot as mentioned. Line 302: 2119 kmËĘ2 Line 303: "In summer, West Africa is influence..." Line 324: this is not a complete sentence. Line 342: be consistent with spaces. Line 343: "Figure 3 shows..." Line 347: "2018). A similar spatial..." Line 400: "As already

depicted in the previous section, " Line 402: control doesn't seem like the right word. Line 427: governed doesn't seem like the right word. Line 434: The estimation {of what} was based on the calculated...? Line 444: this is not a complete sentence. Line 450: "developed by Derwent et al. (2010a)..." Line 459: is it TW-2T or TW2T? Figure 2 caption: "Data were downloaded. . ." Figure 5: Re: caption: be consistent with hyphens. Probably they're not necessary. The fonts used in the plot are difficult to read. Perhaps use a simpler san serif font. Also, this information and the breakdown of the pie charts shown would be far more informative in a table. Figure 8 caption: "(Huang et al., 2017)". And a space is missing after 2011.) Figure 9 caption: "(Huang et al., 2017)". Also, RT and RoadT seems redundant. Please define better.uj Figure 10: caption should read: "Total estimated emissions and relative distributions in the. . . d'Ivoire for the VOC family a) Terpenes, b) IVOCs and c) Aldehydes."

We thank the reviewer for the detailed revision of our manuscript. We have revised the manuscript and changed the typos and errors as suggested.

Table 1: "Two wheelers two strokes" doesn't read very well. Perhaps "Two stroke two wheelers"? Also, should "smuggled oil" be defined? Is this different from all other oils? Smuggled is not referred to elsewhere in the manuscript, which makes me intrigued.

We thank the reviewer for this remark. We have changed the table and text as suggested and also incorporate the information of smuggling oil into the manuscript.

In African countries, two-wheeled vehicles (two-stroke or four-stroke engines) frequently use a mixture of oil and gasoline derived from smuggling, which is characterized by high pollutant emissions (Assamoi and Liousse, 2010).

Table 2: Why ZI YOP? Why not YOP? The latitude for ABO needs to be corrected (remove commas?) and it would be better if it fit on one line like the other locations. The entire table should be adjusted so that the "activity" can be easily associated with each row – it is difficult to read which lines go with which rows to the left.

We have included the suggestions in the table and the typos were corrected.

Table SM1: Should this just be “S1?” Also, the capitalization of VOCs in the table (and naming) is inconsistent. There are several typos in the info near the bottom. The k in kOH is both italicized and not italicized. Instead of using a “+”, perhaps used a superscripted letter and then give the info as a footnote in the table? Why n12 and not n-dodecane? Camphre should be camphor (in English). Why are kOH values being estimated from “analogous species”? Which species? And if some kOH are available, use a different superscript footnote for the kOH values that are estimated from different (specific) species, and also use a different superscript footnote for the SOAP values estimated from different (specific) analogous species. (More information is needed all around.) Again – there are spaces where they don’t and lack of spaces where they do belong.

We thank the reviewer for these significant suggestions. We have included the suggestions in the table and the typos were corrected. Anonymous Referee #2 Received and published: 12 March 2019 This work describes results of VOC analysis of sorbent tube sampling from various regions and sources in and around the SW African coastal city of Abidjan, Côte d’Ivoire. The results are employed to establish fractional molar mass contributions and for the estimation of potential VOC-OH reactivity, ozone and secondary organic aerosol formation. The emissions factors were compared with those reported in global emission inventories (MACCity and Edgar). The huge emission inventory underestimations reported by this work for speciated VOCs particularly when comparing residential and transportation sectors with the computer model inventory estimations makes a good case for the need for more such measurements for the larger West African region.

While I am sure that this manuscript contains a lot of novel data that will be of great value to the emissions inventory community, it is difficult to work out how many samples are measured and exactly what is new in this manuscript, rather than what is already covered by other publications, particularly Keita et al., 2018.

We thank the reviewer for this remark. The manuscript has been thoroughly revised and the material and methods section was rewrote.

It is not until line 545 that I get a better idea of where these new results fit in with those of Keita et al “Our results emphasize the first insights obtained in the work of Keita et al. (2018) : : :) though "emphasize" I feel is not the best word to use... maybe "reinforce"?

The text was changed as suggested.

I agree with the main points raised by the other reviewer, especially that the quality of the English, is not quite good enough for me to be confident I understand all the points that the authors are trying to make – and it certainly makes for slow reading. Therefore I found it difficult to assess the manuscript in its entirety. I also feel that the manuscript needs to be shortened and “streamlined” to make it more accessible to the reader.

We thank the reviewer for the time and effort put in the revision of the manuscript. The paper was thoroughly revised by a native speaker and sections have been rewrote for a better understanding of the reader.

Specific comments (not a comprehensive list): Line 25: “two-wheeled vehicles” sounds more accurate/scientific/less slang than “twowheelers”. The text was changed by two-wheel vehicles

Line 184 and Table SM1 – how many samples represent each category? What are the standard deviations for each category?

We have incorporated the information requested in the supplementary material and in the Sampling section

Line 287 I do not see POCP values for each VOC in Table SM1 Thank you for the comment. We have used the POCP values related to each VOC family as it was reported in the work of Huang et al., 2017. Thus, we finally did not incorporate the individual POCP values in the Table S1

Table SM2 – I do not see any POCP values on my version of the table. Thank you for this remark, the values were incorporated in the Table S2

Line 327 “This analysis relies on the fifteen VOC species already described in Keita et al (2018)” – does this mean that the Keita et al data are used here – or the same chemical species newly measured?

The data presented in Keita et al 2018 was obtained under the same work package of the DACCIWA project. Despite we integrate here the fifteen VOC compounds already assessed in Keita et al., we present them in a deeper analysis, not only by analysing their emission factors but also by evaluating the potential impacts on the regional atmospheric chemistry

Please also note the supplement to this comment:
https://www.atmos-chem-phys-discuss.net/acp-2018-1263/acp-2018-1263-AC1-supplement.pdf

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Interactive comment on Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2018-1263, 2018.