

Interactive comment on “Diel and seasonal changes of Biogenic Volatile Organic Compounds within and above an Amazonian rainforest site” by A. M. Ya nez-Serrano et al.

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We would like to thank anonymous reviewer 2 for his detail comments and suggestions that would substantially improve the final version of the manuscript. We deeply appreciate and acknowledge his concerns and efforts with the aim to improve the manuscript in an optimum way, which would help the future readers and BVOC scientists.

Comment 1: Introduction: The introduction is quite long and unfortunately it misses to guide the reader to the point: Why are we interested in studying biogenic VOCs exactly in the Amazonian rain forest? Isn't this the question which has to be answered to

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the reader before stating the objective in the last paragraph of the introduction? After reading the objective the reader asks, 'Yes, but why exactly is this study important?' – Most likely because this question was not answered completely before. While the first paragraph of the introduction goes into the right direction the further paragraphs serve to introduce every single VOC. However, this information needs to be set into the right context. I would suggest to condense the introduction and close the circuit why the study will contribute significantly to the scientific understanding of the atmospheric distribution of BVOCs and their role in atmospheric chemistry before stating the objective.

Response 1: For better explanation we will add a comment after the first paragraph on why are we interested in studying biogenic VOCs in the Amazonian rainforest. We understand that by explaining of page 29161 the pristine conditions of the Amazon environment allowing the study of continental regions with similar atmospheric condition regimes to before the industrial revolution. We also explain the Amazonian atmospheric photo-reactor (Andreae et al., 2002). At last, in the following page [29162] we explain the importance of BVOC at the different ecosystem levels, detailing their impact in the atmosphere by the possible production and formation of secondary organic aerosols, thus influencing radiation properties as well as cloud processes. We will make two sub-chapters 1.1 in which we will describe the VOC species [of interest] in the Amazonian environment. In addition, we will include a clearer objective of our research study in the Amazon in the introduction.

Page 29162 line 2 [this numeration is according to the ACPD publication page numbering]: “Having in view all these issues it is acknowledged that field observations of BVOCs in the tropics are rare likely due to logistical and technical problems including site access, power requirements, and high ambient humidity and temperatures.”

Page 29164 line 24: “The objective of this study is to provide a detailed description of BVOC in-canopy mixing ratios and fluctuations, which can indicate heterogeneous sources within the canopy and can be related to the exchange between the forest and

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the atmosphere under dry and wet season conditions. Furthermore, the measurements give insight for a new forest site with data obtained at the new Amazonian Tall Tower Observatory (ATTO) site on an 80 m tower.”

Comment 2: I would strongly advise to have a proper language check on the manuscript I figured out a couple of oversights. Some parts of the manuscript – especially in the Results section - are hard to understand because of imprecise statements or improper use of words.

Response 2: We gratefully acknowledge the advice and we will carefully rechecked the document for language mistakes.

Comment 3: I wondered why the authors did not try to measure or calculate fluxes. With a shorter dwell time for the VOCs e.g. 0.2 s (as e.g. in the case of methanol) one could try to calculate above canopy fluxes e.g. by means of the virtual disjunct eddy covariance method (Karl et al., 2002) given that 3D wind measurements are available at the corresponding altitude. Although I understand that the switching between different altitude levels and sequential measurements (using a single PTR-MS) make continuous flux measurements challenging. However, it would have been valuable to have at least an imagination of the BVOC fluxes during the different seasons especially for the discussion. Further, I expected to see measurements of other atmospheric pollutants like ozone or NO_x to support the discussion part of the manuscript which is partially quite speculative. Were there any ozone and NO_x measurements at the site? If yes it would be good to integrate them to support the discussion.

Response 3: We have had many discussions regarding ecosystem-scale flux calculations amongst the authors and arrived at the decision that flux calculations under these circumstances would result in large uncertainties due to the unconstrained turbulence conditions within and above the forest canopy. See response to comment 1 from reviewer 1. Measurements of other pollutants at the site, such as ozone and NO_x will be discussed in detail in a future manuscript (Wolff et al, in preparation). However, our ob-

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servations represent the first BVOC measurements at the ATTO tower site and include other novel aspects such as diurnal and seasonal dynamics as well the first vertical gradient observations of methyl ethyl ketone demonstrating biogenic emissions and acetonitrile demonstrating anthropogenic uptake.

Comment 4: Title: As the authors refer to the forest with the words ‘within and above’ please remove the word site from the title.

Response 4: We will remove the word “site”.

Comment 5: Page 29160, line 10: ‘(February/March 2013 and September 2013)’, please insert wet season and dry season to clarify which seasons are meant.

Response 5: We will do as suggested. See response to comment 3 from reviewer 1.

Comment 6: Page 29160, line 21-25: This part is rather cryptic. Specify why ‘OVOC patterns’ indicate this transition. The word pattern is not meaningful. The sentence: ‘This was inferred from the high mixing ratios found within the canopy, and those obtained above the canopy for the wet and dry season, respectively’ does not clarify which patterns the authors refer to (a reader doesn’t know the figures at this stage of the manuscript).

Response 6: We will rewrite this sentence more clearly. See response to comment 3 of reviewer 1.

Comment 7: Page 29160, line 28: The last sentence of the abstract does not relate to anything what was written before although the start ‘In addition,’ indicates this. Consider rewriting or clarify the connection between this sentence and the one before.

Response 7: We will change the text to:

Page 29160 line 28: “Considerable differences in magnitude of BVOC mixing ratios, as compared to other reports of Amazonian BVOC, demonstrate the need for long-term observations at different sites and more standardized measurement procedures

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in order to better understand the natural exchange of BVOC between the Amazonian rainforest and the atmosphere.”

Comment 8: Page 29165, Site description: The main part of the information which is given in section 3.2. (Time series) would be important to have in the site description. In my opinion a site description is also thought to introduce site, climatic conditions, and characteristics in the seasonality.

Response 8: Yes we agree and we will include a 2.2 section in the materials and methods explaining the time of measurements. See response 9 to reviewer 1.

Comment 9: Page 29166, line 19: The authors write: ‘Humidity dependent calibrations (using bubbled synthetic air, regulated as close as possible to ambient humidity conditions) were performed’ why did you not use the zero air to dilute your gas standard? Which dilution steps did you use for your calibration? What were typical sensitivities for your PTR-MS?

Response 9: We used humidified zero air to dilute the standard. We will insert the different calibration steps as well as the wet and dry season sensitivity for each calibrated compound. Please note, that the limit of detection (LOD) is already described just before.

Page 29166 line 19: Humidity dependent calibrations (using bubbled zero air to dilute the standard, regulated as close as possible to ambient humidity conditions) were performed using a gravimetrically prepared multicomponent standard including methanol (m/z 33; ncps/ppb = 10.73 wet season and 9.11 dry season), acetonitrile (m/z 42; ncps/ppb = 22.82 wet season and 19.07 dry season), acetaldehyde (m/z 45; ncps/ppb = 21.71 wet season and 18.41 dry season), acetone (m/z 59; ncps/ppb = 22.69 wet season and 19.88 dry season), isoprene (m/z 69; ncps/ppb = 6.03 wet season and 8.51 dry season), MVK+MVK (m/z 71; ncps/ppb = 20.34 wet season and 16.37 dry season), MEK (m/z 73; ncps/ppb = 16.95 wet season and 17.91 dry season) and α -pinene (m/z 137; ncps/ppb = 0.029 wet season and 0.52 dry season and m/z 81; ncps/ppb = 4.98 wet

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season and 5.63 dry season) with dilution steps ranging from 22 to 0.8 ppb (Ionicon, Austria for the wet season and Apel and Riemer for the dry season).

Comment 10: Page 29166, line 19: Please exchange ‘multicomponent standard of formaldehyde’ by ‘multicomponent gas standard including formaldehyde.’

Response 10: We will be modified accordingly.

Comment 11: Page 29166, line 25: Ionimed does not exist anymore. Ionimed and Ionicon consolidated under the name Ionicon. Did I understand it right and the standard was bought at Ionicon but originally it was from Apel and Riemer? Please note: write ‘Apel and Riemer’ not ‘Apel and Riemer’ and consider including the habitat.

Response 11: Two different calibration cylinders were used, one for the wet season which was the Ionicon one, and another one for the dry season. This will be specified in the text and the wording for Apel and Riemer will be modified accordingly. See response to comment 9.

Comment 12: Page 29166, line 25 and following lines: The authors write: ‘Monoterpenes were monitored at m/z 81 (mass calibrated independently for α -pinene, Pearson coefficient for m/z 81 against m/z 137: 0.71), its main fragment, instead of the unfragmented m/z 137’ A Pearson correlation coefficient of 0.71 is quite low (Rsquare of approximately 0.5) which means that only 50 % of the variability on mass channel 81 is explained by m/z 137. You are aware that on m/z 81 there are also other compounds, e.g. a fragment of the leaf wound compounds (Fall et al., 1999)? With such a low Pearson correlation coefficient it would be better to cope with the lower detection limit and quantify monoterpenes directly using the m/z 137.

Response 12: We understand your concern and we take it as ours. We had a relatively low correlation between m/z 137 and m/z 81 likely due to the noise of m/z 137 rather than overlapping of compounds. We will include this information in the text as specified in response to comment 10 from reviewer 1.

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Comment 13: Page 29167, line 3-9: 'The PTR-MS technology allows for fast sampling at very low mixing ratios, but the system relies solely on mass-over-charge (m/z) for compound specification. As such, cross validation with another compound selective technique, such as Gas Chromatography is strongly advised. This was performed using the GC-FID (Gas Chromatography-Flame Ionisation Detector) technique for monoterpenes () and isoprene.' I advise to write: 'The PTR-MS technology allows for fast sampling at very low mixing ratios, but the system relies solely on the mass to charge ratio (m/z) for compound specification. To cross validate compounds gas chromatography was performed for monoterpenes (.) and isoprene using a GC-FID (gas-chromatography-flame ionization detector)'.

Response 13: We appreciate the suggestion and we will modify the specific part accordingly.

Page 29167 line 3: "The PTR-MS technology allows for fast sampling at very low mixing ratios, but the system relies solely on mass-over-charge (m/z) for compound specification. To cross validate compounds gas chromatography was performed for monoterpenes (α -pinene, camphene, 1-octen-3-ol, sabinene, β -pinene, myrcene, α -phellandrene, 3-carene, α -terpinene, -cymene, limonene and δ -terpinene) and isoprene using a GC-FID (Gas chromatography-flame ionization detector)."

Comment 14: Page 29167, line 19-22: How did you estimate the uncertainties? Did you, for example, include errors of flow controllers during the calibrations?

Response 14: Yes we did include mass flow controllers' uncertainties, calibration gas uncertainties, etc. We used the theory of propagation of error and it will be added to the text.

Page 29167 line 17: "The uncertainty of the PTR-MS was calculated according to the error propagation method (Doerffel, 1984) taking into account the uncertainty of the calibration (including multicomponent gas standard and mass flow controllers errors), of the PTR-MS itself and the background error."

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Comment 15: Page 29168, line 19-21: 'Finally, butanal could also have been a contributor, but GC-FID values for butanal had a mean of 0.01+-0.04 ppb (n=104) and thus we considered it as negligible. Therefore, we regarded m/z 73 as representing MEK.' You wrote before that you did not perform compound specification by GC-FID for m/z 73. Thus the sentence is confusing.

Response 15: Yes we agree it is confusing and thus we will remove the sentence and leave as final sentence for that paragraph:

Page 29168 line 19: "Thus, despite the possible contributions from other compounds to m/z 73 are plausible, we regard MEK as a major contributor to the signal."

Comment 16: Page 29169 line 22, section 'Time series': The information given here fits more to the site description or site characterization. Consider moving this part accordingly. Moreover, the title time series is meaningless - it does not refer to the information given in this section.

Response 16: We agree and we will add a 2.2 section at the M&M to describe the measurement periods. However we believe that some of the information in the section 3.2 is part of the results as it is the analysis of the meteorological conditions among seasons. We also decided to change the time series title to "Analysis of meteorological parameters". See response to comment 9 from reviewer 1.

Comment 17: Page 29170, line 25: Suggest rewording to 'During the night (median for the time period 00:00-03:00 LT), however, isoprene mixing ratios above the canopy were considerably higher than within canopy'.

Response 17: We will rephrase accordingly.

Page 29170 line 24: "During the night (median of the period of 00:00-03:00 LT), however, isoprene mixing ratios above the canopy were considerably higher than within the canopy (Figure 4)."

Comment 18: Page 29171 ff: You refer to the vertical profiles always within special time

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periods. I guess referring to them as midday, afternoon, night (after a proper definition) would make it easier for the reader and probably also for the authors as one already has to cope with the different altitudes.

Response 18: We understand that time periods for statistics do not represent a general daylight period (i.e. the whole afternoon, the whole midday period), and therefore we prefer to use the exact time range as used for statistics.

Comment 19: Page 29171, line 22: are you talking about the rsquare or the Pearson correlation coefficient?

Response 19: This specific text will be removed (See comment response to comment 12 from reviewer 1) but we meant Pearson.

Comment 20: Page 29171, line 25/26: be precise – how did you take transport and chemistry into account?

Response 20: As transport and chemistry was not directly treated, this text will be removed.

Comment 21: Page 29172, line 5-7: Do you mean: 'Dry and wet season data of MVK + MACR showed a clear seasonality and large differences magnitude'? Please rewrite accordingly.

Response 21: Thank you for the suggestion. This sentence will be rewritten for clarity.

Page 29172 line 5: "Dry and wet season data of isoprene oxidation products showed a clear seasonality and large differences in magnitude between the seasons."

Comment 22: Page 29172, line 14-15: I don't understand the sentence Consider rewriting.

Response 2: We will rewrite to:

Page 29172 line 14: "Mixing ratios below the canopy were usually 0.1 ppb lower than

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above the canopy throughout the day".

Comment 23: Page 29172, line 21: 'During this time of the year' it is not clear to which season you refer to. I guess the dry season? Please clarify!

Response 23: We will modify it to "dry season" instead of this time of the year.

Comment 24: Page 29173, line 15-16: 'Although the highest mixing ratios were found at the canopy top, the diurnal cycle with a pronounced increase around noon suggested a biogenic origin. ' Although'? The one does not exclude the other. Why would it be unusual to believe in a biogenic origin of the OVOCs just because ratios at the top of the canopy (and not within the canopy) were highest? I guess the insulation is strongest at the canopy top.

Response 24: To clarify, we will exchange the word "although" with "with".

Page 29173 line 15: With the highest mixing ratios found at the middle of the canopy, the diurnal cycle with a pronounced increase around noon is consistent with biogenic emissions from canopy vegetation.

Comment 25: Page 29173, line 19-20: where is the difference between above the canopy and at the top of the canopy? Comparing to Fig 1. 24 m is more inside the canopy than at the top. It would be easier to have the proper altitude in brackets (the corresponding figure only shows 0.5,24 and 79m). Reading through the last paragraph I have the feeling that different terminologies are used for the same altitudes (which is quite confusing) please define a uniform terminology for each altitude and use that consistently. Maybe include a proper definition to Figure 1 next to the altitude.

Response 25: The terms ground, middle of the canopy and above the canopy can be easily derived from the figure and set into context with the height. We will carefully use a uniform terminology in the revised version. In addition we will change "top of the canopy" for "middle of the canopy" (see response to comment 24).

Comment 26: Page 29173, line 27-28: Would this behavior refer to a difference in dom-

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inating sources necessarily? What about a difference in sinks (stronger photochemistry at the canopy top) or stronger vertical mixing?

Response 26: Yes you are right. After “dominating sources” we will include “and sinks, as well as possible differences in the vertical mixing”.

Page 29173 line 27: “Such difference clearly indicated a seasonal change in the dominating sources and sinks, as well as possible differences in the vertical mixing for this species.”

Comment 27: Page 29174, line 15: You refer here to the limit of detection for methanol which is –by the way - exceptionally high... Referring to table 1, I found that the dwell time for methanol is just 0.2s instead of 1 s as for most of the other compounds. Is there a reason choosing this dwell time? Increasing dwell time means also decreasing the limit of detection.

Response 27: Due to the need to measure more masses per height during a vertical profile (only 2 min at each height), the dwell times for some masses were reduced. The tradeoff is an increased limit of detection for methanol.

Comment 28: Page 29174, line 20-24: This belongs more to the discussion than to the results. Additionally you write ‘could be the photochemical oxidation of VOCs’ Unclear – do you mean photochemical oxidation of other VOCs that degrade to methanol or do you mean a photochemical sink for methanol.

Response 28: We agree and we will remove this par as it is already mentioned in the discussion.

Comment 29: Page 29175, line 6-12: This belongs into the discussion. Additionally the statement that Acetonitrile typically originates from biomass burning requires a reference.

Response 29: We are agree and we will move it to the discussion.

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Page 29181 line 2: “Distinct biomass burning plumes were not observed. This indicates that there was no biomass burning close-by impacting our measurements, and impact from long-range transport may be assumed. Such burning activities can be expected during this time of the year (Karl et al., 2007a). In addition the observation that levels decrease towards the ground could indicate a potential uptake by soil bacteria, although wet deposition cannot be excluded. The variability of the measurements especially inside the canopy occults a possible influence by plant emissions which has previously been reported (Bange and Williams, 2000; Nyalala et al., 2011).”

Comment 30: Page 29176, line 1-3: The statement is speculative the lower methanol mixing ratios could be a consequence of lower emissions as well (maybe because of decreased insulation). That the reduced mixing ratios of methanol are a consequence of uptake at wet plant surfaces is a hypothesis which has to be supported by references (e.g. Laffineur et al., 2012). I would suggest to tone down and include references.

Response 30: We thank the referee for this contribution. We decided to include it as a reference rephrase as following:

Page 29176 line 1: “Finally, the mixing ratios of water soluble compounds, such as methanol, might also be influenced by the wet plant surfaces (Laffineur et al., 2012) emphasizing the seasonal trend that originated from reduced emissions.”

Comment 31: Page 29176, line 9: I guess you mean an increase in the variability of BVOC mixing ratios? Please clarify.

Response 31: The clarification will be inserted.

Page 29176 line 9: “In addition, an increase in the variability of BVOC mixing ratios above the canopy was observed in the dry season, with mixing ratios inside the canopy sometimes reaching the above canopy levels.”

Comment 32: Page 29176, line 13-14: The second part of the sentence is hard to understand. Consider rewriting!

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Response 32: We agree and we decided to write the sentence as:

Page 29176 line 11: "Most likely this was due to the higher insolation during the dry season which results in high upper canopy leaf temperatures and turbulent mixing above the canopy during the day. Thus, this higher variability might also have been influenced by changing environmental conditions, seasonal differences in plant emission potential, variation in the oxidative capacity of the atmosphere influencing secondary BVOC production rates, and transport of air masses from other regions."

Comment 33: Page 29176, line 16 – Page 29177 line 6: The two paragraphs come out of the blue here and disturb the flow of reading especially as the next paragraph (starting at page 29177 line 7) connects well to the paragraph in front (ending at page 29176 line 15) of the two mentioned ones. I suggest to remove them here. If the authors think the information is required it needs to be included somewhere where it fits better.

Response 33: We agree but we believe the information is necessary for the discussion as it provides a climatic comparison with other forested ecosystems as well as a phenological link to climatic conditions in the Amazon region, important for understanding the seasonality of BVOC in the Amazon. Therefore, we will place those two paragraphs at the beginning of section 4.1 Diel and seasonal behavior (Page 29175 line 125).

Comment 34: Page 29177 line 7: The long range transport of what? You probably mean the long range transport of NO_x enriched air masses? Please clarify. There are a couple of mistakes like that throughout the manuscript. Even if the reader can guess what the authors mean it would improve the manuscript a lot if the authors state clearly what they mean.

Response 34: We will modify accordingly.

Page 29177 line 7: "During the dry season, long range transport of NO_x enriched air masses from other regions, including biomass burning air masses, could have triggered

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a higher oxidative capacity of the air as indicated by higher ozone and NO_x concentrations at the ATTO site during the dry season (Wolff, S. personal communication, 2014)."

Comment 35: Page 29177 line 7-17: It sounds like there are ozone and NO_x measurements at this site. If measurements of ozone and NO_x at this measurement site are available at the corresponding time they should be included to support the discussion about atmospheric degradation which is a bit speculative without measurements of other atmospheric pollutants.

Response 35: See response to comment 3.

Comment 36: Page 29177 line 11: 'the rise of ozone and NO_x' do the authors refer to the personal communication here? See comment above.

Response 36: Yes we do refer to the personal communication from the study Wolff et al. In particular we refer to the increase in ozone and NO_x mixing ratios consequent from higher mixing ratios during the dry season as compared to the wet season.

Comment 37: Page 29177 line 15: 'and vertical patterns' as you refer to differences during the wet and dry season as well please include that.

Response 37: We agree and we will include among seasons after vertical patterns.

Page 29177 line 14: "Summarizing, the different mixing ratios and vertical patterns among seasons can be related to changes in insolation, temperature, external sources (i.e. biomass burning air masses during the dry season) and leaf phenology, all related to seasonality."

Comment 38: Page 29177 line 18ff: It is well known that isoprene emissions are light dependent. Please insert a reference.

Response 38: We will include a reference here.

Page 29177 line 18: "Isoprene peaked together with light intensity just after midday

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inside the canopy during the dry and the wet season (Guenther et al., 1996).”

Comment 39: Page 29178 line 4ff: I think I didn't get the point of discussion here How efficiently isoprene can escape from the canopy by transport depends on the nocturnal boundary layer (NBL) height which is usually quite low. During the night there is usually no or only very weak vertical mixing and horizontal transport below the NBL leads to the transport of air masses which originate as well from rain forest canopy. Please clarify what you want to state.

Response 39: We agree it may be unclear and we will modify to:

Page 29178 line 28: “This decrease just after sunset was too rapid to be explained exclusively by gas-phase chemistry due to a decrease in the levels of OH which does not have major sources in the dark (Goldan et al., 1995). Under these conditions a decrease in isoprene mixing ratios can be partially explained by ceasing photosynthesis. Ozonolysis of alkanes during the night can be neglected due to the low ozone levels (Paulot and Orlando 1996; Andreae et al., 2002). This potentially important process becomes more visible during the night, when the nocturnal boundary layer results in low transport rates (with a wind speed at 19m of $0.23 \pm 0.17 \text{ m s}^{-1}$) with diffusion being the main trigger. Under these conditions, the profile of isoprene with lower mixing ratios to the ground during the night clearly indicated a sink at the surfaces (such as leaves, soil and/or litter). Presumably isoprene was lost as well to microbial consumption (Goldan et al., 1995; Cleveland and Yavitt, 1997; Gray et al., 2014).”

Comment 40: Page 29178 line 18: If you refer to previous studies please include the corresponding references here.

Response 40: We agree and we will include the reference.

Page 29178 line 17: “A few Amazonian tree species have been monitored for monoterpene emissions in previous studies, suggesting that more factors than solely meteorological influence the seasonality of monoterpene emissions (Kuhn et al., 2004; Bracho-

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Nunes et al., 2013).”

Comment 41: Table 2: The authors write ‘values are reported as medians and means during daylight periods as reported in the references’. If you report the values here it should be stated for every value if it is mean or median and for which time period. I would suggest using footnotes.

Response 41: We agree, we will add a subscript specifying if the number it is a mean or a median in the table 2 caption.

Comment 42: Figure 2: Please include measurement altitude into the figure, e.g., write Isoprene levels at 24 m (ppbv) as y label.

Response 42: We will revise as suggested.

Comment 43: Units: I would suggest to change ppb to ppbv throughout the whole manuscript.

Response 43: After very careful discussions with all coauthors we do not agree on changing the unit as we are not talking about an ideal gas. In addition, only if the M is specified after ppb [ppbM] is referring to mass mixing ratios rather than that you are not talking about volume mixing ratios.

Comment 44: Figure 4 -10: The colored boxes around each plot to indicate if it is dry season or wet season data are redundant. It is written in words in each plot and already obvious without the boxes. Please remove the boxes.

Response 44: We will remove the colored frames.

Comment 45: Page 29178 line 26ff: A switching of the metabolic processes? I think this sounds very speculative Do you have any references?

Response 45: See response to comment 17 from reviewer 1.

Comment 46: Page 29180 line 18-20: Why not both? You stated above that NOx

C11406

enriched air masses were transported to the site. These air masses could have been enriched in MeOH as well.

Response 46: We agree and we will modify to:

Page 29180 line 18: "For the dry season, the overall higher mixing ratios above the canopy is consistent with both enhanced photochemical production within the troposphere and transport of biomass burning impacted air masses"

Comment 47: Page 29181 line 11: The sentence sounds like the authors did investigate the plant species in the Amazonian rain forest among different seasons, which they did not. Please consider rewriting!

Response 47: We agree and we will clarify.

Page 29181 line 10: "Due to the immense area of the Amazonian ecosystem and the paucity of measurements, a great variability of plant species (Hans ter Steege et al., 2013) and atmospheric BVOC levels is observed in the Amazon basin."

Comment 49: Page 29181 line 27- Page 29182 line 5: Please rewrite the corresponding sentences they read odd.

Response 49: We agree they read odd and we will modify to:

Page 29181 line 27: "In agreement with Kanakidou et al., (2005), further efforts on monoterpene characterization in terms of abundance and reactivity in Amazonia are needed for a better understanding of SOA growth and formation processes, regionally as well as worldwide. In addition, the oxidative capacity of the atmosphere can be studied based on the oxidation products of isoprene. Across the Amazon region mixing ratios of isoprene oxidation products are always higher above the canopy and during the dry season (Table 2), especially when measured in the mixed layer by aircrafts (Karl et al., 2007; Kuhn et al., 2007) or tethered balloons (Kesselmeier et al., 2000) suggesting a higher oxidative capacity during the dry season above the canopy."

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Comment 50: Page 29182 line 12: What do you mean by 'to improve our understanding of BVOC'?? Do you mean 'BVOC emission, transport and chemistry'?

Response 50: We meant that and we will modify it the text.

Page 29182 line 9: "Therefore more continuous measurements with a better representation in space and height are needed to investigate the seasonality of within and above canopy interactions with the atmosphere to improve our understanding of BVOC emissions, transport and chemistry over Amazonia."

Comment 51: Page 29182 line 20-23: The two sentences are unclear. Do you mean something like 'Marked seasonality and diurnal behavior of BVOC patterns was observed at the site as seen in their seasonal and vertical changes' You start the next sentence with 'This' and refer to the sentence in front. The text would be easier to follow if you would write something like: 'These changes in VOC mixing ratios were attributed'.

Response 51: We appreciate the detailed feedback. We agree it is unclear and we will change it to:

Page 29182 line 20: "Marked seasonality and diurnal behaviour was observed at the site, as seen in the BVOC mixing ratios seasonality and vertical profiles. These changes in BVOC mixing ratios were attributed to changing sources of these compounds mainly in relation to seasonal fluctuations of light, temperature and phenology."

Comment 52: Page 29183 line 1. 'This indicates a mixture of sources ' What about sinks?

Response 52: Yes, you are right. We will also include sinks in the sentence.

Page 29183 line 1: "This indicates a mixture of sources such as vegetation emissions, oxidation from primary emitted BVOCs and regional atmospheric transport as well as sinks."

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Comment 53: Page 29183 line 4-7: Although the authors are right with the general statement I guess vertical profiles of mixing ratios in combination with ozone and NO_x and maybe also BVOC flux measurements would be most useful and would leave much less room for speculation as BVOC mixing ratios alone.

Response 53: See response to comment 3.

Technical issues: Comment 54: Throughout the manuscript: Sometimes you write oxidation capacity sometimes you write oxidative capacity. I guess oxidative capacity is the right terminology. Please check that and use a uniform terminology.

Response 54: We agree and we will modify all terms to oxidative capacity.

Comment 55: Page 29160, line 4: I suggest to write: 'biogenic volatile organic compounds', usually it is not necessary to capitalize each first letter to introduce an acronym. This refers also to other acronyms.

Response 55: We will modify all capital letters explaining an acronym.

Comment 56: Page 29160, line 7: 'Proton Transfer Reaction Mass Spectrometer': Please decide for a uniform notation all over the manuscript (compare page 29166 line 10 where you write 'Proton Transfer Reaction-Mass Spectrometer'). I would also suggest starting every word in small letters.

Response 56: We will modify to the initial one to Proton Transfer Reaction – Mass Spectrometer and thereafter we will refer to the instrument as PTR-MS.

Comment 57: Page 29165, line 20 and Page 29166, line 9: The acronym for volatile organic compounds was already introduced before.

Response 57: We will use the acronym.

Page 29165 line 20: "Measurements of VOC mixing ratios were accompanied by the determination of total OH reactivity, nitric oxide."

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Page 29166 line 9: "Measurements of VOCs were performed using a PTR-MS."

Comment 58: Page 29169 line 5: I suggest to write: 'A cross validation for isoprene and monoterpene data obtained by in-situ PTR-MS measurements was performed off-line analyzing absorbent tubes by GC-FID (Fig.2)'.

Response 58: We will modify accordingly.

Comment 59: Page 29170, line 23: Suggest rewording to 'During daytime isoprene showed highest mixing ratios'.

Response 59: We will modify as specified.

Comment 60: Page 29170, line 26/27: Suggest rewording to 'Strong gradients towards the ground were seen especially for the dry season'.

Response 60: We will modify accordingly.

Comment 61: Page 29171, line 2: you write 'In addition, the variability increased during the dry season' variability increased compared to what? Be precise.

Response 61: We agree and we will modify the text to:

Page 29171 line 2: "In addition, the variability increases during the dry season compared to the wet season, as observed in the difference of IQR of 1.9 ppb during the wet season to 6.1 ppb during the dry season, at 24 m for the period 12:00-15:00."

Comment 62: Page 29171, line 4/5: 'Both seasons had similar vertical profiles' technically wrong please correct for example: 'Within canopy (24 m) similar vertical profiles of isoprene were seen for the dry and the wet season during midday (12:00-15:00)'.

Response 62: We agree and we will modify to:

Page 29171 line 4: "Within canopy (24 m) similar vertical profiles of isoprene were seen for the dry and the wet season during midday (12:00-15:00) and at night the highest values were found at the highest inlet."

C11410

Comment 63: Page 29171, line 7: What do you mean with relatively stronger? And compared to what? Be precise.

Response 63: We agree and we will modify the text to:

Page 29171 line 7: "However, the vertical profiles for isoprene during the wet season had a relatively stronger night-to-day variability at 24 m, as compared to the dry season, despite the overall lower mixing ratios during this period. The less pronounced vertical gradient during the dry season could be due to a stronger turbulent mixing (Figure 5)."

Comment 64: Page 29172, line 25: The ground levels cannot show a diurnal variability. I guess you mean mixing ratios at the ground level? Please check the manuscript properly! There are a couple of mistakes like that. Moreover it is not clear what the authors mean – do they mean a diurnal pattern with diurnal variability or do they mean that the variability shows a diurnal pattern? Use precise language.

Response 64: We agree and we will modify to:

Page 29172 line 25: "The ground level mixing ratios showed a night-to-day variability with respect to the wet season, though remained the lowest at this height."

Comment 65: Page 29173, line 1-2: 'The minimum of the MVK+MACR-to- isoprene ratio was located inside the canopy.'???

Response 65: We will rephrase to:

Page 29173 line 1: "Iox-to-isoprene ratios during the wet season were lowest in the middle of the canopy at 24m, and increased near the ground and above the canopy."

Comment 66: Page 29173, line 17-18: The mixing ratios remained much lower compared to what?

Response 66: We will modify to:

Page 29173 line 17: "The mixing ratios above the canopy and at the ground remained

C11411

much lower than within the canopy (24m), throughout the measurement period, except for acetone."

Comment 67: Page 29178 line 19: Better: 'Among those factors' instead of just 'Among those'.

Response 67: We will change accordingly.

Page 29178 line 19: "Among those factors are the oxidative capacity of the atmosphere and phenological development, which may be accentuated during the dry season (Kuhn et al., 2004)."

Comment 68: Page 29179 line 10: Please insert 'compared to isoprene' after 'proportionally'.

Response 68: We will change it accordingly.

Page 29179 line 9: "Even though mixing ratios of isoprene oxidation products and isoprene rose during the dry season, they did not rise proportionally compared to isoprene."

Comment 69: Page 29179 line 12: Please insert 'production' after 'MVK + MACR'.

Response 69: We will insert the change.

Page 29179 line 10: "Whereas isoprene had a 4-fold increase from the wet to the dry season, isoprene oxidation products had a 10-fold increase, possibly indicating a faster depletion of isoprene than isoprene oxidation product production."

Comment 70: Page 29180 line 6: Change to 'MEK, however, showed a less pronounced increase above the canopy.'

Response 70: We will modify accordingly.

Comment 71: Page 29181 line 2-4: If you move the sentence 'Such burning activities' in front of the sentence 'As we did not observe' it fits better to the context.

C11412

Response 71: We will modify the text to:

Page 29181 line 2: "Distinct biomass burning plumes were not observed. This indicates that there was no biomass burning close-by impacting our measurements, and impact from long-range transport may be assumed. Such burning activities can be expected during this time of the year (Karl et al., 2007)."

Comment 72: Page 29181 line 23: Please change 'This compares' to 'The values compare'.

Response 72: We will change it accordingly.

Comment 73: Page 29182 line 7: Change to: 'Among the studies listed in table 2 we reported highest mixing ratios'.

Response 73: We will change it accordingly.

Comment 74: Page 29183 line 4: 'site, height and season'.

Response 74: We will change it accordingly.

Page 29183 line 3: "The summary of BVOC mixing ratios in the Amazonian ecoregion (Table 2) shows an enormous variation depending on site, height and season."

Interactive comment on Atmos. Chem. Phys. Discuss., 14, 29159, 2014.