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Comment

## ***Interactive comment on “Ecosystem-scale compensation points of formic and acetic acid in the central Amazon” by K. Jardine et al.***

**K. Jardine et al.**

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Comment 1: This manuscript reports compensation points of formic and acetic acid based on field measurement using a PTR-MS. These acids have multiple emission and/or production sources and are known to be important as highly water soluble atmospheric constituents. As the authors described in the report, there are quite limited knowledge on the emission of these acids in the terrestrial forest. The report showed that exchange of the acids can change between emission and deposition through dry and wet seasons. The compensation points of the acids are also determined based on the measurement. These information are useful for atmospheric modeling and also are important to improve the atmospheric science while tropical forest is one of the largest emission source of biogenic organic constituents. However, reviewer think that

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the manuscript requires some modification on the presentation and discussion before the publication in Biogeosciences.

Response 1: We greatly appreciate the helpful comments on our manuscript by Anonymous Referee #1, which helped improve our manuscript. Our responses to each of the comments and the changes made to the manuscript are provided below.

Comment 2: In introduction, authors mentioned the acids are important to change the water solubility of the CCN. Reviewer agrees with that the most important feature of the acids in biosphere-atmosphere interaction is their influence on activity of the CCN. However, there is no detailed discussion in the discussion section. Authors should discuss about influences of the emission and deposition of the acids on the CCN activity though dry and wet seasons. Authors should clarify why the acids are important although they are not very reactive and although atmospheric concentration of the acids are not very high during wet season when there is net emission of the acids.

Response 2: We believe that the relationship between emission and deposition of FA and AA and CCN activity in the dry and wet seasons deserves much greater attention but is beyond the scope of the present work. We focus on estimating an ecosystem compensation point for FA and AA and characterizing the exchange of the acids between the primary tropical forest and the atmosphere throughout the dry and wet seasons.

Comment 3: In L10p9295, authors insist that deposition of the acids is mainly controlled by dissolution into water phase. There should be appropriate reference of calculation to prove the water amount and surface is enough to dissolve the large quantity of the acids while the emission and production of the acids are assumed to be high.

Response 3: We suggest that in addition to water solubility, rapid metabolic consumption of FA and AA within leaves contributes to their efficient atmospheric uptake.

Comment 4: nmol mol<sup>-1</sup> might be described as ppbv (please refer rules for BG).

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Response 4: This issue was discussed during the initial review process prior to publication in BGD and it was suggested that the SI units  $\text{nmol mol}^{-1}$  is the appropriate SI unit for mixing ratios in BG. Although we agree with the use of SI units, we prefer to let the editor decide which unit (ppbv versus  $\text{nmol mol}^{-1}$ ) is appropriate for BG.

Comment 5: L27p9289, mb should be written in an appropriate SI unit.

Response 5: mb is now converted to the appropriate SI unit (Pa). Line 168: "...drift tube pressure of 2.0 mb (200 Pa)."

Comment 6: Detailed description is required for (Brazil) and (Biosphere2) in L26p9290.

Response 6: We now include a more detailed description. Line 194: "In Brazil, a Teflon tee connected to the PTR-MS was overblown with 500 sccm of ultra high purity nitrogen after passing through a hydrocarbon trap (Restek). In Biosphere 2, a Teflon tee connected to the PTR-MS was overblown with 500 sccm of ultra high purity zero air (produced using an AADCO 737-series Pure Air Generator with a catalytic converter)."

Comment 7: Authors described that inlet of the PTR-MS was warmed to avoid adsorption of the acids (L23p9290). How about sample line at the tower? Because the sample line is very long, adsorption may be very serious without heating (L22p9292). Authors should describe detailed information about this adsorption issue in the field measurement.

Response 7: We now include a description of our heated gas inlet system for vertical concentration profiles at the tower. Line 255: "To prevent condensation and minimize FA and AA losses during sampling, all Teflon gas inlets were continuously heated to  $\sim 50^\circ\text{C}$  using self-regulating heating tape (Omega Engineering) in an insulated jacket."

Comment 8: In L15p9293, is this enclosure measurement? Authors should clearly describe procedure of the measurement at the early part of the paragraph to help reader's understanding.

Response 8: We now provide a brief description of the enclosure measurements. Line

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279: “In this study, dynamic Teflon branch enclosures were used to study diurnal patterns in FA and AA emissions from several tree species within the Biosphere 2 tropical rainforest mesocosm.”

Comment 9: The enclosure measurement can only see net emission (or deposition) of the acids. The ratio between emission and deposition for the enclosure measurement should be described if possible. It should be described that the enclosure measurement only shows net emission at least.

Response 9: We are not clear on how to separate emission from deposition for the enclosure study. However, we specify that these enclosure experiments can only show net emissions. Line 333: “However, because of the use of purified air in the branch enclosures and the semi-closed nature of the rainforest mesocosm, net uptake was prevented. Therefore, these features are useful to isolate the FA/AA emission ratios from tropical vegetation while eliminating secondary photooxidation and other potentially dominant sources in the Amazon like biomass burning. However, the bidirectional exchange nature of ecosystem-atmosphere exchange, as has been observed using ambient air in individual plant enclosures (Bode et al., 1997; Kesselmeier, 2001; Kuhn et al., 2002), requires an analysis of ambient air in a natural forest.”

Comment 10: Tani et al. (2008) EST should also be referred as earlier report of desorption of VOC by vegetation.

Response 10: We now include this excellent reference in the introduction. Line 125: “For example in a recent study, atmospheric uptake of low-molecular weight aldehydes and ketones by peace lily (*Spathiphyllum clevelandii*) and golden pothos (*Epipremnum aureum*) leaves revealed that the total uptake amounts were 30–100 times as much as the amounts dissolved in the leaf (Tani and Hewitt, 2009). These results suggest that many oxidized VOC can be rapidly metabolized upon entering a leaf.

Comment 11: Fig. 2 and 3 needs error bars for uncertainties of concentration measurement. It is useful to indicate canopy height in these plots by dashed lines.

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Response 11: Due to the large number of curves on each graph, we do not include error bars in Figs. 2 and 3 for clarity sake. Instead we list the typical relative standard deviation for the concentration measurements in the figure captions.

Comment 12: Fig.5 It is useful to indicate dry and wet seasons by shaded area in the plot.

Response 12: Dry and wet seasons are now indicated by shading in Fig. 5.

## References

Bode, K., Helas, G., and Kesselmeier, J.: Biogenic contribution to atmospheric organic acids, in: Biogenic Volatile Organic Compounds in the Atmosphere, edited by: Helas, G., Slanina, Steinbrecher R, SPB Academic Publishing, Amsterdam, 1997.

Kesselmeier, J.: Exchange of short-chain oxygenated volatile organic compounds (VOCs) between plants and the atmosphere: A compilation of field and laboratory studies, Journal of Atmospheric Chemistry, 39, 219-233, 2001.

Kuhn, U., Rottenberger, S., Biesenthal, T., Ammann, C., Wolf, A., Schebeske, G., Oliva, S. T., Tavares, T. M., and Kesselmeier, J.: Exchange of short-chain monocarboxylic acids by vegetation at a remote tropical forest site in Amazonia, Journal of Geophysical Research-Atmospheres, 107(D20), 8069, Doi 10.1029/2000jd000303, 2002.

Tani, A., and Hewitt, C. N.: Uptake of Aldehydes and Ketones at Typical Indoor Concentrations by Houseplants, Environmental Science & Technology, 43, 8338-8343, Doi 10.1021/Es9020316, 2009.

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Interactive comment on Biogeosciences Discuss., 8, 9283, 2011.

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