

# ***Interactive comment on “Variations in soil chemical and physical properties explain basin-wide variations in Amazon forest soil carbon densities” by Carlos Alberto Quesada et al.***

## **Anonymous Referee #2**

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Review of soil-2019-24 Title: Variations in soil chemical and physical properties explain basin-wide variations in Amazon forest soil carbon densities Corresponding Author: Carlos Alberto Quesada

General comments This paper focuses on the controls of SOC stabilization and retention in different soil orders across the Amazon Basin. The dataset is impressively large, and there is value in the findings. However, significant changes to the writing need to be addressed. The paper is too long and the sentences are often poorly constructed, burying the amazing findings as a result! A heavy revision and resubmission of the paper is recommended in order to condense the paper, make the writing more

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straightforward and direct, and to address a few important questions addressed below. There are also too many figures with too many colors and shapes, which both dilutes the impact of individual graphs and muddles the findings. Lastly, this is an incredible amount of work for a poorly studied region in terms of its soils, and this paper would benefit from emphasizing this fact!

Specific comments/questions: -Introduction is far too long and spends too much time on general soil chemistry processes (i.e. lines 70-124). Much of this is background knowledge (i.e. line 105 “The extent to which DOM precipitates is largely influenced by soil pH”). This is not a process-based paper but a broad geographic survey of soil carbon concentrations, and the introduction should reflect the breadth and focus of the paper. -Be clear about what work was completed in this paper. Parts of the methods and results include references to previous work, which should belong in the discussion section (Line 295: “based on a previous analysis of a subset of sites”). -As previously stated, the biggest issue is the writing. The paper is far too long and the grammar construction is too verbose and confusing. Additionally, the Results section needs to be heavily revised. Rather than saying “Figure X shows...”, state the findings and put the figure at the end. I.e. for Section 3.2 (Line 316-319), the length of these sentences could be halved if the writing was instead: “Mineralogy of LAC and HAC soils were distinctly different based on PCA analysis (Figure 3a). -The 2nd biggest issue is this work heavily relies on a previous paper’s work. In the methods, Section 2.2 (Line 179), the author writes as if the soil classification was performed in this study. However, in Section 3.1 (Line 294), it turns out this clustering was performed by a previous study. -Terminology needs to be consistent and clear. Use specific p-values. Do not switch between “less weathered” and “low activity clays” to define for instance the 1st group. Those two descriptors do not mean the same thing. -Some QA/QC reporting for the soil density fractionation is needed. Why that particular subset of samples? And what was the recovery of soil mass and soil carbon? Were there reps? SDF analysis is often coupled with a reporting of sample recovery in the Appendix. -Remove the analysis of temperature and precipitation controls. The paper is stronger

without it. Temperature is not highly variable in this region. Rather precipitation is. However, the focus on the paper is on the mineralogical controls of SOC preservation and stabilization. Precipitation and temperature can be brought up in the discussion, especially for the Arenic soils. -Be upfront about the number of soils in each group. It appears the numbers are not consistent based on Fig. 1. How is this accounted for statistically to ensure against bias. -Lastly, land-use change is an equally important threat to this region!! What is the situation in terms of deforestation and how is that expected to change in the future? Consider this alongside climate change in both the intro and discussion.

Technical corrections/Line-by-line comments: L25 – are you sure all of these soils are “pristine”? “Minimally disturbed” might be more appropriate.

L31-33 – Omit beginning part of sentence “SOC fractionation studies further showed that. . .” – let the focus of the sentence be on the findings

L36-38 – run-on sentence and complicated phrasing “and with this mechanism enhanced by.” Sentences need to be more straightforward and direct.

L24-45: Title uses the word densities, but abstract focuses on soil carbon concentrations and soil carbon stocks. Keep language consistent

L45: Rather than end on a negative result (“aboveground biomass nor precipitation. . .were found to exert any influence. . .”), end on a more powerful positive finding. . . i.e. soil and litter qualities are more powerful predictors!

L49-60: What is the focus of this paragraph? This is a list of facts that don’t work together towards an overall point such as soil carbon stocks being equally as important as biomass carbon in Amazon forests.

L70 & throughout the paper: Try to use a more active voice than passive. I.e. “clay mineralogy controls specific surface area” in line 70.

L79-80: Mention anion exchange capacity

L73 and L76: Be consistent in your terminology – “Hydrous Fe and Al oxides” vs “Iron and Al hydrous oxides” – pick one and refer to it consistently

L122: Do not assume reader will know why Fe-associated co-precipitation is considerably less important than Al precipitation

L126: Edaphic factors involve physical (temperature, precipitation) and biological factors, but the previous paragraphs have focused on chemical factors. There is a large leap from chemical stabilization to all edaphic factors without an explanation for why.

L132: Wade et al. 2018 is a more recent citation.

L140: Be precise, not vague. What does “more similar weathering levels” mean, and how is that different from chemical and mineralogical characteristics? Aren’t those two descriptors collinear?

L142-143: Instead of “less weathered,” can you say more rich in X, Y, Z?

151: Omit “may”

154: Be succinct! Instead, say “Here we explore the climatic. . .

158: Make the main action verb (“associated”) more clear

170: “Usually” is not a scientific word! Please omit

164-176: Study site needs more information. How many different soil orders were covered by these 147 plots? This is a big omission that should not be left to a table or figure but succinctly described in the paragraph. Additionally, line 142 has information that should be included in the section under study site not in the introduction. Bring the reader up to speed. How accurate are the classifications for this region as well?

165: “Primary forest plots” means something different than “Pristine forest plots” (Line 25). Be consistent

176: WHY are only the top 30 cm reported?? This needs to be explained and the entire

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paper needs to better reflect this. For instance, mention this depth in the Abstract.

212: How was this subset of sites chosen to ensure a representative subsample?

232: Omit the sentence about leaf litter lignin estimates. That should be included in section 2.1 when the previous studies are mentioned.

259-271: Was it bulk soil XRD (<2mm) and the clay fraction, or just bulk soil?

275: What does SRTM stand for?

294: Begin the results section with the findings, not a description of a figure. It is confusing whether this cluster analysis was completed in this study or in previous work.

298: Need to define low activity clays and high activity clays in the Introduction – this seems to be an important part of the paper

306-313: What were the ranges in CEC and clay %? Were the average values for these 3 groups significantly different?

315: For the mineralogy, it is important to know what fraction of these soils are clay-sized

330: Be precise, what does varying proportions mean?

343: Give exact p-value

348-350: Confusing sentence, I don't understand it at all.

355: An appropriate way to demonstrate higher variability is to give the coefficient of variation for both groups

378: Instead of all the acronyms, which are hard to keep track of, can you say cation exchange capacity instead of IE?

403-406: Knowing the clay fraction of these two soil groups is essential to interpreting the data

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430: 3.5 Soil carbon/mineralogical associations is not an appropriate subtitle when the association between leaf litter and C storage is explored

534: Is 0.49 a percentage, a mass??

656: The discussion subheadings need to be consistent. I.e. if you use low activity clays for one heading, use high activity clays rather than less weathered soils for the following heading. Also, why the change to “retention” for 4.1.2?

661: Rather than lumping other studies into the same sentence as your results, separate their findings into a different sentence.

690-691: I don't understand why the sand and aggregate fraction is lumped together. In soil density fractionation studies, it is often the light fraction (free organic matter), occluded light fraction (organic matter bound up in aggregates), and the dense mineral fraction (residual organic matter bound to minerals). This latter group can be subdivided into clay+silt, and then sand. But to clump sand and aggregate fraction together makes no sense.

767: I would be very careful with such a statement. I'm sure this process of AI/OM interactions has been studied elsewhere. Focus instead on your findings, which are interesting in and of themselves! 833-834: Do you mean biomass carbon inputs impacting soil carbon stocks? It feels like some key adjectives are missing here.

838-840: This is a classic example of this paper's poor writing. Be direct, be concise! For instance, “Our findings do not negate the possibility that future climatic changes will have a significant impact on soil carbon stocks in the Amazon Basin.”

Fig. 1 – This is not a systemized, randomized design across the Amazon Basin. These plots are clustered by geographic area. I think a more appropriate statistical approach would be to cluster these sites by location and compare between groups. This is essential for considering the effects of precipitation and temperature. Within and between group variability needs to be addressed.

Fig 11. – I do not understand this graph at all, which is unfortunate because I can tell it has important results!

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