

Functional composition of the Amazonian tree flora and forests

Corresponding Author: Professor Hans ter Steege

Version 0:

Reviewer comments:

Reviewer #1

(Remarks to the Author)

The authors have compiled an impressive dataset and present interesting results at multiple scales along with detailed information about functional traits of trees across Amazonia. I understand word constraints in the abstract but some more detail would be helpful to round out some of the statements already made in the abstract. There are many instances where numbers reported in the text do not match those found in the tables. I have highlighted some of these instances below, but these should all be checked.

Lines 72-74: Can brief detail be added as to what the 13 functional traits of 812 tree genera were used for?

Line 75: which axis explains most of the trait variance?

Line 103: The abstract says 812 tree genera but here it says 353. I see in the methods that trait data was only available for 353. Consider changing the abstract.

Lines 133-134: I'm not sure this information is needed since this figure doesn't actually show these results.

Line 148: Supplementary Table 1a reports 22.97% of the variance

Line 155-157: This sentence is repeated.

Line 165: Maybe change to families combined to keep it consistent with Fabaceae being a family

Line 165-167: Maybe move this sentence above the sentence that starts Line 164 to introduce that you separately tested Fabaceae and then present the results.

Line 176: I can't see any traits in bold in Table 1

Line 216: Why not mention pH, supplementary figure 3b here?

Line 274-276: Where is this reported in Supplemental Table 2b, maybe Supplemental Table 2c?

Supplement:

Line 173: This says 12 traits but the table list 13. Also the eigenvalues reported in the table legend are different from those in the actual table.

Line 193: What the life history abbreviations stand for should be added to the legend.

Lines 238 and 242: Can these figure titles be updated to note that one figure shows forest types and the other shows Amazonian regions?

Line 346: c and d should be reversed

Line 440: Is this figure missing?

Reviewer #2

(Remarks to the Author)

General comments

This study provides an impressive dataset on forest communities from the Amazonian region. Based on their abstract and intro, their goal was 1) to test whether trait distributions align with well-known spectrums, such as the leaf economic or size spectrum. 2) to investigate whether these trait axes are conserved across phylogenetic scales (species and genus levels). 3) to explore the role of habitat filtering in trait alignment, and 4) to investigate the relationship between functional composition and ecosystem function (e.g., carbon storage and sequestration). However, the manuscript lacks a focused structure and straightforward overarching research question, obscuring its main message. Additionally, the introduction needs more work in how it is framed and needs much background information that logically leads to the questions. As it reads, it feels that this

is more than one paper that was forced into one. Given the number and complexity of the questions, the study would benefit from narrowing its scope or framing it as a series of interconnected studies with more depth in each. Currently, key messages are difficult to discern from the figures and text, and the results and discussions are challenging to follow.

Specific Suggestions

Make a clear separation between results and discussion. The results section contains interpretive commentary that is better suited to the discussion, while some results reappear in the discussion. Separating these sections would improve readability. Note that the discussion also contains information that should be included in the introduction.

Reduce Abbreviations. The manuscript has over 20 abbreviations, which impact readability. Minimizing them would make the manuscript more reader-friendly.

Restructure the Methods section. Separate data collection from data analysis. Organize methods by research question and indicate which questions each part addresses. It might be good to add also study region if readers aren't aware of all different region names from the Amazon basin and their characteristics.

Move main results to main. Many of the results mentioned in the results sections are not even placed in the results section but in supplementary materials. A paper should stand on its own, limit to supplements information on sensitivity analyses or complementary results. Maybe the fact that there are too many results is an indication that this should be more than one paper?

Abstract

Add the Main Question and Conclusion. Include a clear overarching question and a concluding sentence to enhance focus.

Line 74: Clarify if this is a novel result or already known. As it is written, it sounds like this was already known.

Introduction

Please make more explicit an introduction/overview of the various known spectrums, and specify which ones are tested. Provide definitions and add a rationale for focusing only on habitat filtering.

Second paragraph: What would you expect in each scenario? Make clear what the question or questions are. It needs more background info on what is actually known. Present a cohesive aim that links questions together to avoid a fragmented narrative.

Line 91: isn't this the fungal collaboration gradient Bergmann et al, 2020?

Line 104: "including above- and below-ground traits and reproductive traits" it is not clear which traits you are including and why. This needs a better overview. Indicate which traits are included and why. A trait table linking traits to axes or spectrums would clarify things better.

Line 107: It is unclear which strategy axis you are referring to. Also, it is not clear which spectrums you are testing. You mention different ones, also using different names for the same spectrum at different places of the manuscript. Keep consistency.

Line 111: I miss the big aim that encompasses all those questions that justify answering four different questions. It feels a bit too many big questions that could be placed in more than one paper.

Lines 116-120: I miss a more elaborate rationale, maybe introduced earlier in the intro, so that the question becomes logical. How do you expect that habitat filtering would modify the traits spectrums?

Results

I miss the main findings' results and how they answer each question. A direct link to the question with a brief description of how this was tested/analyzed is needed. Write results in order of questions as appear in intro. Where is the habitat filtering before ecosystem functioning? I am missing the promises of below ground traits, dispersal, and all the other spectrum that were mentioned in introduction.

Line 145: Specify whether this is at the species-genus level, low taxonomic scale, or fine scale.

Line 156: What is the stature-recruitment trade-off? Is this related to which spectrum? Give an overview of spectrums/strategies with their trade-offs and related traits, specifying which ones you are testing/focusing on in this paper. You will make the reader's life much easier and make the paper clearer and more focused.

Lines 156-158: remove repeated sentence.

Line 165-170: where are the results for Fabaceae? If this is a main result that needs to be placed in the main. Alternatively, just refer to it (if it shows in-line results with the complete data) and refer to the supplement.

Table 1. It seems that dispersal is considered as a single trait. However, dispersal is a complex trait, and many dispersal-related traits are used as proxies. Which specific trait did you use and why? Take into account that each dispersal trait can contribute differently to overall dispersal and depends on taxonomic scale. What were the outcomes of dispersal? Moreover, dispersal comes out of the blue, in Table 1 is the first time where it is mentioned.

Line 186: is the novel question whether there are community-level strategies and whether those reflect species-level ones? The second question is about habitat filtering. How does this filter act on the axis of variation? Where/how was this precisely tested?

186-188: I am not sure to which PCA they are referring to, Fig1b is the PCA with traits are the genus level. Same as in line 199. Not community but genus level

Line 211 – 215: "We evaluated how environmental factors (soil pH, sum of bases, annual rainfall, cumulative water deficit, windthrow count, convective atmospheric potential energy), past human disturbances and management (domesticated species²⁴ and geoglyph-probability²³)

Note that human-related impacts were not introduced before. Also, it is unclear how this is measured, how it relates to your questions, and what you are testing. Clarify what is geoglyph probability and why this is relevant. Introduce the domesticated species and geoglyph.

Also, which life-history strategies are these ones and how differ from the traits already use to quantify community functional composition? This wasn't introduced either. What is the question and what is the hypothesis behind?

Line 216: which soil characteristics were included?, please do as you did in line 219 for climatic factors.

Fig. 2. "The order of regions also appears follow general soil fertility" do not assume readers know this, this isn't show in the results. How do we know that this is true? Include a plot showing this in me supplements. Define lines in box plots (e.g., center line, data percentage in box).

Fig. 3. This is a nice graph. To make it more appealing I would choose a different color combination, remove the number of the isolines (as they are already in the legend). Check for color blind friendly combinations.

Have a consistent caption with the graph: "Forests with a negative score (blue) are the opposite in terms of trait values and occur mainly on nutrient rich soils. The isolines divide Amazonia into three regions, tough-slow ($PC1 > 0.65$, yellow-beige), soft-fast ($PC1 < -1.2$ blue-purple) and intermediate (green)." Are the isolines you mentioned the same as the colors on the legend?

Note that there isn't purple in the graph. I would change the color gradient to a blue gradient for negative values and yellow-orange gradient for positive. Why the legend seems to show a categorical classification (also colors in map) and not a continuous gradient? What are the criteria for classification? maybe add in legend which ones are the fast and slow ... so it is easier to interpret the figure

Line 263: not very clear how the sentence: "PC1 shows a spatial pattern not unlike most traits" is supported by Fig.3. Please state a clear message and check that figures do actually support the message of the sentences. The same comment goes for other figures.

Lines 263-269: this needs a bit more context, all those forest names might not mean anything to a reader not familiar with the Amazon. Do as it was done in line 268 and 269

Lines 267-278: this is a discussion

Line 281: "To assess if individual CWM traits follow the same patterns as the multivariate PC1 gradient of Fig3." This is not a research question. Can you write each of your results paragraphs based on the research questions you promised to solve?

Lines 282-283: this might fit better in the legend of fig 3. Which needed much clarification. Also where is the trait distribution shown?

Lines 283-285: no idea where to look, and I am also not sure whether this is a main result or not, even though you have a complete (mini) paragraph for this. If it not, then move it to supplements.

Line 286: comparing genus vs. community level? In introduction you promise a comparison between genus and species level. Not clear to which research question this other comparison refers to. Make this connection clear and state what you found. In addition, I don't see relevant supporting results in the main text.

Lines 296-297: "Indeed, above ground woody biomass (AGB) is 296 significantly positively related to PC1." I suggest to place PC1 between (). And instead write here something that actually means something for readers, such as the fast-slow continuum, the leaf economic spectrum, etc. This would make it less abstract.

Lines 304-306: You are only showing relative productivity. Where are the other tests on composition and turnover?

Fig. 4. put color meaning in a legend. Also add in figure x axis: fast -> slow

Discussion

Lines 320-321: expand more, what would you expect if including other growth forms?

Lines 327: This would be clearer in the results if maybe would be more explicit or add some icons on the PCA

Line 329-333: which result are you referring to?

Line 335: "stature-recruitment trade-off" this is the first time that this is mentioned

Line 347-350: I haven't seen this in the results. You refer here to supplements... main results should be placed in main. Note that this seems main as you started the paragraph with this. Same for the correlations.

Line 377: those are results.

Line 400-462: this is intro. ItCan be more concise and added to have a good background of this study. The specific traits, processes can be placed, for instance, in a box.

Line 464: this wasn't introduced before. How does this relate to your questions? How was this analyzed? and what are the outcomes?

Conclusions:

Conclusion 1: is this not something that was already shown? Then, rephrase it.

Line 530: what is the spectrum? How was this tested?

Conclusion 5: Presenting a map isn't a conclusion; what do you conclude from this map and how exactly will it be used in the future?

Methods

Line 540: are these nested in the genus-level plot ones, or are they different plots?

Line 548: add "species-level" before "plots"

Line 554: specify which traits you used and to which spectrum they relate.

Line 563: there is only one map in the main text. Specify

Line 578: what was the coverage for height?

Line 589: replace ATDN for forest plots, do not complicate the reading on purpose.

Line 591: a spatial model of what?

Version 1:

Reviewer comments:

Reviewer #1

(Remarks to the Author)

The authors had done an excellent job of addressing the reviewers' comments. In particular, I appreciate the effort the authors put in to expanding the introduction.

Line 91: change less to fewer

Line 109: increase

Line 113: would this be increases with soil fertility?

Line 122: maybe clarify that it's a do-it-yourself strategy for acquiring resources or outsourcing strategy that relies on fungi

Line 146 What does observed much earlier mean?

Line 231: is 44% correct, using later PC axes explain less of the total variation

Line 619: The statistical analyses undertaken should be added here, even if brief. What R package was used for PC analyses, what package for Mantel test, etc?

Reviewer #2

(Remarks to the Author)

I congratulate the authors for their excellent work! The manuscript has significantly improved and is now much easier to follow. The removal of abbreviations is well done. The abstract is straightforward and to the point. The introduction is now well-explained; I've learned much from it. Using subtitles in the discussion provides a clear structure, which is nicely done. Below are a few small minor comments and suggestions:

Line 87: Please specify that this is the seed size-seed number tradeoff.

Line 132: Add a brief sentence explaining the relevance of Aluminium accumulation.

Line 141: The sentence "Thus, under favourable conditions, plants will show traits that allow them to grow fast and to compensate for herbivory, but at a cost of being more weakly defended against herbivores" is a bit unclear. Are plants growing fast to compensate for herbivory, or do they compensate differently? If so, how does this make them weakly defended? Clarifying this point will help avoid potential misinterpretation.

Line 513: In the sentence "vegetation models and earth system models such as 104, and 105," it seems like the model names are missing. If you are referring to specific authors, perhaps add the names of the models for clarity.

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Reviewer #1 (Remarks to the Author):

The authors have compiled an impressive dataset and present interesting results at multiple scales along with detailed information about functional traits of trees across Amazonia. I understand word constraints in the abstract but some more detail would be helpful to round out some of the statements already made in the abstract. There are many instances where numbers reported in the text do not match those found in the tables. I have highlighted some of these instances below, but these should all be checked.

Thank you for your kind words. In the last week before submitting the manuscript a brand-new paper on nectar presence of plants in Brazilian ecosystems was published and the first author added that as it showed interesting results. However, many numbers changed and some were not updated. My apologies for that and thank you for noting.

All changes and new sections are marked yellow in the new MS.

Lines 72-74: Can brief detail be added as to what the 13 functional traits of 812 tree genera were used for?

For the abstract only 200 words are allowed for *Communications Biology*. We have tried to get more of the questions and results in but as you can understand, 200 words is rather limiting. Instead, we have expanded the introduction including information on all traits. To summarize: all 13 traits of 353 genera (those that had no missing data for any trait, complete cases in R language) were used to construct a PCA at genus level (PCA 1). Secondly, for all traits we calculated the community weighted means, based on all 812 genera and all 2253 plots and analysed this by region and forest type and mapped it (Suppl. figures 7 – 24) and suppl. text. We then used all CWMs for the 13 traits of the species-level plots (2054) to construct PCA 2, where we used the genus level trait data for all traits but breeding, which was done at species level.

We hope this elaboration now makes it clearer.

Line 75: which axis explains most of the trait variance?

That is the first PCA axis, now called the ‘fast-slow forest spectrum’ (line 251).

Line 103: The abstract says 812 tree genera but here it says 353. I see in the methods that trait data was only available for 353. Consider changing the abstract.

We collected trait data for all 812 genera but only for 353 data was available for all 13 traits (in R language: complete cases). For the first (genus-level) PCA we only used the 353 genera for which we had data on all traits. Data of all 812 genera was used to make the individual trait analyses and single-trait maps (suppl. figures 7 – 24). This is explained in lines 518-526.

Lines 133-134: I'm not sure this information is needed since this figure doesn't actually show these results.

The figure did include these results, but truth be told that it was not very visible. We have now split 1a and 1b back to figure 1 and 2, and modified the axis so that the variables are better visible (Fig. 1, Fig. 2).

Line 148: Supplementary Table 1a reports 22.97% of the variance
22.97 is the correct number, it has been corrected in the text (Line 207).

Line 155-157: This sentence is repeated.
We have deleted this sentence.

Line 165: Maybe change to families combined to keep it consistent with Fabaceae being a family
This has been done (Line 224).

Line 165-167: Maybe move this sentence above the sentence that starts Line 164 to introduce that you separately tested Fabaceae and then present the results.
This has been done (line 221 – 230).

Line 176: I can't see any traits in bold in Table 1
This was an omission; we have now removed the bold font. What is deemed important was in fact subjective. Given the comment by the reviewer, we have deleted the text as well stating this from the main text (Table 1).

Line 216: Why not mention pH, supplementary figure 3b here?
We did not mention this before as the SB was much better, given the reviewer comments, pH has been added now (Line 265).

Line 274-276: Where is this reported in Supplemental Table 2b, maybe Supplemental Table 2c?
The reviewer is correct, this should have been 2c, we have corrected this.

Supplement:

Line 173: This says 12 traits but the table list 13. Also, the eigenvalues reported in the table legend are different from those in the actual table.

This has been corrected, one trait was added in a very late stage. The same goes for the Eigenvalues.

Line 193: What the life history abbreviations stand for should be added to the legend.

This has been now added (Suppl. Table 1b).

Lines 238 and 242: Can these figure titles be updated to note that one figure shows forest types and the other shows Amazonian regions?

We have updated the figure to accommodate the reviewer' suggestion (Line 247, 252).

Line 346: c and d should be reversed

This has been corrected (Line 357 – 364)

Line 440: Is this figure missing?

Is the reviewer referring to OGS? In our version it is there, we don't see a figure missing.

Reviewer #2 (Remarks to the Author):

General comments

This study provides an impressive dataset on forest communities from the Amazonian region.

Thank you for your kind remark and extensive comments. They have certainly helped to improve the manuscript. In fact, a lot of the requested info was in the introduction before but because of space limits and because some of the writing team considered it too much, it was shortened. Apparently, we overdid this but have now again included it.

Given the reviewer lists a number of elements deemed to need a better structured embedding, we provide some context below directly, before going into the specific comment.

All changes and new sections are marked yellow in the new MS.

Based on their abstract and intro, their goal was 1) to test whether trait distributions align with well-known spectrums, such as the leaf economic or size spectrum.

Indeed, because the important paper of Diaz et al included herbaceous plants (small and not woody) the traits related to size were expected to be important in the study, but here we worked with large woody taxa only. So, it was not sure if this axis would appear as most important one (or at all). The introduction has been changed a bit to make this more evident.

2) to investigate whether these trait axes are conserved across phylogenetic scales (species and genus levels).

This was actually not the case. We assume that most traits are conserved at the genus level (based on known data, as is also explained in the methods), but we do not test it. Question 2 was about upscaling, i.e. do the genus level trait spectra appear in a similar way in the community trait spectra.

3) to explore the role of habitat filtering in trait alignment,

Correct, question 3 is to find soil/climate/human factors that may drive the changes and distribution across Amazonia.

and 4) to investigate the relationship between functional composition and ecosystem function (e.g., carbon storage and sequestration).

Indeed, question 4 is to investigate if the community trait spectra (assessed by the PCA axes) may drive forest function (here biomass and productivity).

However, the manuscript lacks a focused structure and straightforward overarching research question, obscuring its main message. Additionally, the introduction needs more work in how it is framed and needs much background information that logically leads to the questions. As it reads, it

feels that this is more than one paper that was forced into one. Given the number and complexity of the questions, the study would benefit from narrowing its scope or framing it as a series of interconnected studies with more depth in each. Currently, key messages are difficult to discern from the figures and text, and the results and discussions are challenging to follow.

Thank you for your extensive comments. Because the manuscript was first submitted to a journal with a stronger space restriction we tried to be as concise as possible and cut out much of an earlier version. Much of that now re-appears in the introduction. We hope it is now clearer again. See also our answer to this effect to reviewer 1.

Specific Suggestions

Make a clear separation between results and discussion. The results section contains interpretive commentary that is better suited to the discussion, while some results reappear in the discussion. Separating these sections would improve readability. Note that the discussion also contains information that should be included in the introduction.

We have done that and hope we have accommodated reviewer 2.

Reduce Abbreviations. The manuscript has over 20 abbreviations, which impact readability. Minimizing them would make the manuscript more reader-friendly.

We have gone over the manuscript and most abbreviations should be removed now, unless they serve a specific purpose.

Restructure the Methods section. Separate data collection from data analysis. Organize methods by research question and indicate which questions each part addresses. It might be good to add also study region if readers aren't aware of all different region names from the Amazon basin and their characteristics.

We have done that and hope it is better now.

Move main results to main. Many of the results mentioned in the results sections are not even placed in the results section but in supplementary materials. A paper should stand on its own, limit to supplements information on sensitivity analyses or complementary results. Maybe the fact that there are too many results is an indication that this should be more than one paper?

Most (if not all) of the results in the supplementary material is on the analyses of the single traits, rather than the overall comparison of signals at the different levels (i.e. genus versus community). We disagree that all should be in the main paper, as this is not the core subject of our study. We do strongly believe it should be part of this paper, because it provides more detailed information (as complementary results).

The comparison PCA1 and PCA2 is, however, rewritten and hopefully clearer now.

Abstract

Add the Main Question and Conclusion. Include a clear overarching question and a concluding sentence to enhance focus.

We have changed the abstract to accommodate reviewer 2, given the word limit we have not been able to elaborate in much detail.

Line 74: Clarify if this is a novel result or already known. As it is written, it sounds like this was already known.

This is indeed already known. The two spectra are found in most cases, as we do here. But the main results are the scaling up to communities and the forest function.

Introduction

Please make more explicit an introduction/overview of the various known spectrums, and specify which ones are tested. Provide definitions and add a rationale for focusing only on habitat filtering.

Habitat is rather extensive

Second paragraph: What would you expect in each scenario? Make clear what the question or questions are. It needs more background info on what is actually known. Present a cohesive aim that links questions together to avoid a fragmented narrative.

The introduction has been expanded considerably to provide the information asked. We hope it is more informative now.

Line 91: isn't this the fungal collaboration gradient Bergmann et al, 2020?

Yes, and we have made that clearer in the introduction (Line 118 - 125).

Line 104: "including above- and below-ground traits and reproductive traits" it is not clear which traits you are including and why. This needs a better overview. Indicate which traits are included and why. A trait table linking traits to axes or spectrums would clarify things better.

The introduction has been expanded considerably on explaining the traits. As mentioned, this was also in a previous version but it was thought that we should be as short as possible. It is clear we were too short. Thank you for this comment and we hope to have accommodated your comments in the new introduction.

More information on the traits and how they relate to trade-off is and was also available in Supplementary Box 1.

Line 107: It is unclear which strategy axis you are referring to. Also, it is not clear which spectrums you are testing. You mention different ones, also using different names for the same spectrum at different places of the manuscript. Keep consistency.

We have added the names of the two main spectra in the introduction and refer to these consistently throughout the manuscript (Lines 88 and 103)

Line 111: I miss the big aim that encompasses all those questions that justify answering four different questions. It feels a bit too many big questions that could be placed in more than one paper.

With the rewriting of the introduction and shifting text, that should be much clearer now.

Lines 116-120: I miss a more elaborate rationale, maybe introduced earlier in the intro, so that the question becomes logical. How do you expect that habitat filtering would modify the traits spectrums?

The changes we have made in the introduction should now cover this rationale and we hope to have accommodated reviewer 2.

Results

I miss the main findings' results and how they answer each question. A direct link to the question with a brief description of how this was tested/analyzed is needed. Write results in order of questions as appear in intro. Where is the habitat filtering before ecosystem functioning? I am missing the promises of below ground traits, dispersal, and all the other spectrum that were mentioned in introduction.

We restructured the results in such a way that it answers the questions separately and moved discussion to discussion. The below ground traits have also been added. Dispersal was not considered a trait in our data (as it comes in many flavours). Fleshy fruits and seed mass are, however, traits important for dispersal. The legend of table 1 and 2 should make that clear now.

Line 145: Specify whether this is at the species-genus level, low taxonomic scale, or fine scale.

This was at genus level, which has now been added (line 202).

R2 Line 156: What is the stature-recruitment trade-off? Is this related to which spectrum? Give an overview of spectrums/strategies with their trade-offs and related traits, specifying which ones you are testing/focusing on in this paper. You will make the reader's life much easier and make the paper clearer and more focused.

We have added this in the expanded introduction (line 103) and use this name throughout the text.

Lines 156-158: remove repeated sentence.

This has been deleted.

Line 165-170: where are the results for Fabaceae? If this is a main result that needs to be placed in the main. Alternatively, just refer to it (if it shows in-line results with the complete data) and refer to the supplement.

We prefer to keep it in the text and the figure in the supplement and modified the text (line 221 – 227).

Table 1. It seems that dispersal is considered as a single trait. However, dispersal is a complex trait, and many dispersal-related traits are used as proxies. Which specific trait did you use and why? Take into account that each dispersal trait can contribute differently to overall dispersal and depends on taxonomic scale. What were the outcomes of dispersal? Moreover, dispersal comes out of the blue, in Table 1 is the first time where it is mentioned.

Dispersal is not treated as a singular trait here. Fruit fleshiness is a trait related to dispersal, as mentioned above. We have named the column type and explained in the legend of Table 1.

Line 186: is the novel question whether there are community-level strategies and whether those reflect species-level ones? The second question is about habitat filtering. How does this filter act on the axis of variation? Where/how was this precisely tested?

PCA 2 is about the relationship between traits at community level and if this is the same as for genera (question 2). We have modified the text to specify this more clearly (line 228...)

186-188: I am not sure to which PCA they are referring to, Fig1b is the PCA with traits are the genus level. Same as in line 199. Not community but genus level

This is at community level – heading. Genus-level and community-level now have their own figure (Fig. 1 and Fig.2 respectively. We hope the text reflects that better now.

Line 211 – 215: “We evaluated how environmental factors (soil pH, sum of bases, annual rainfall, cumulative water deficit, windthrow count, convective atmospheric potential energy), past human disturbances and management (domesticated species²⁴ and geoglyph-probability²³”

Note that human-related impacts were not introduced before. Also, it is unclear how this is measured, how it relates to your questions, and what you are testing. Clarify what is geoglyph probability and why this is relevant. Introduce the domesticated species and geoglyph.

They were, but very short. They are better explained in the expanded introduction (line 177 – 184).

Also, which life-history strategies are these ones and how differ from the traits already use to quantify community functional composition? This wasn't introduced either. What is the question and what is the hypothesis behind?

We have now provided a more elaborate explanation in the revised introduction (177 - 184).

Line 216: which soil characteristics were included? Please do as you did in line 219 for climatic factors.

These were the sum of bases and pH. Both have now been included (Line 265 and further).

Fig. 2. “The order of regions also appears follow general soil fertility” do not assume readers know this, this isn’t show in the results. How do we know that this is true? Include a plot showing this in me supplements. Define lines in box plots (e.g., center line, data percentage in box).

Note that this has now become fig 3. There is a lot of literature on this but we have added plot soil data to construct soil fertility by plot and region, based on data that relates to several of the forest plots (Supplementary fig 30).

Fig. 3. This is a nice graph. To make it more appealing I would choose a different color combination, remove the number of the isolines (as they are already in the legend). Check for color blind friendly combinations.

Thank you, note that this has now become fig. 4. We prefer to keep the isolines in to enhance the regions. We have used this colour combination more often and it seems to be OK.

Have a consistent caption with the graph: “Forests with a negative score (blue) are the opposite in terms of trait values and occur mainly on nutrient rich soils. The isolines divide Amazonia into three regions, tough-slow ($PC1 > 0.65$, yellow-beige), soft-fast ($PC1 < -1.2$ blue-purple) and intermediate (green).” Are the isolines you mentioned the same as the colors on the legend?

The isoclines indeed refer to the same gradient of PC1 scores.

Note that there isn’t purple in the graph. I would change the color gradient to a blue gradient for negative values and yellow-orange gradient for positive. Why the legend seems to show a categorical classification (also colors in map) and not a continuous gradient? What are the criteria for classification? maybe add in legend which ones are the fast and slow ... so it is easier to interpret the figure.

We have cross-referenced this using different screens and it seems to depend on the screen whether the purple is visible. If in the proofs no purple is visible, we will take it out. The criteria for the legend colours are simply a standard way by R to make a legend. Continuous may be a bit nicer but not strictly necessary.

Line 263: not very clear how the sentence: “PC1 shows a spatial pattern not unlike most traits” is supported by Fig.3. Please state a clear message and check that figures do actually support the message of the sentences. The same comment goes for other figures.

We have modified the text and hope it is clearer now (Line 310 – 312).

Lines 263-269: this needs a bit more context, all those forest names might not mean anything to a reader not familiar with the Amazon. Do as it was done in line 268 and 269

We have modified that paragraph (Line 274 – 288)

Lines 267-278: this is a discussion

We have now moved it to the discussion section (Line 395 – 407)

Line 281: “To assess if individual CWM traits follow the same patterns as the multivariate PC1 gradient of Fig3.” This is not a research question. Can you write each of your results paragraphs based on the research questions you promised to solve?

It is an a-posteriori test to see if all traits show a continuum from fast to medium to slow. Text to this effect has been added (Line 307 – 312).

Lines 282-283: this might fit better in the legend of fig 3. Which needed much clarification. Also where is the trait distribution shown?

See answer above. Trait distribution is in the Supplementary figure for each trait (Suppl. Figs 8 – 25)

Lines 283-285: no idea where to look, and I am also not sure whether this is a main result or not, even though you have a complete (mini) paragraph for this. If it not, then move it to supplements.

As this is an a-posteriori test (see above), it has to be mentioned here to refer to the supplement. We hope the text on this is clearer now. (line 307-312)

Line 286: comparing genus vs. community level? In introduction you promise a comparison between genus and species level. Not clear to which research question this other comparison refers to. Make this connection clear and state what you found. In addition, I don’t see relevant supporting results in the main text.

We do not promise a test between genus and species level. For most traits we use genus level data, for breeding species-level data. Perhaps the confusion was caused by the very short introduction, as we have now expanded on this, we hope this is now clearer (see also our response to question two).

Lines 296-297: “Indeed, above ground woody biomass (AGB) is significantly positively related to PC1.” I suggest to place PC1 between (). And instead write here something that actually means something for readers, such as the fast-slow continuum, the leaf economic spectrum, etc. This would make it less abstract.

We now use the ‘fast-slow forest spectrum’ now and hope to have accommodated reviewer 2.

Lines 304-306: You are only showing relative productivity. Where are the other tests on composition and turnover?

We are unsure to what reviewer 2 is referring. We did not plan a test on composition. Trait composition is in fact condensed in PC1, the 'fast-slow forest spectrum. We also did not plan for turn-over, just the productivity relative to standing biomass. However, we have included a very short note on turn-over in the discussion and a suppl. Fig 30.

Fig. 4. put color meaning in a legend. Also add in figure x axis: fast -> slow

Fig 5. We have added a textual colour legend description.

Discussion

Lines 320-321: expand more, what would you expect if including other growth forms?

To clarify, we would have expected that the size-recruitment would be more important if herbs were included. We have now elaborated on this to make this clearer (Line 337).

Lines 327: This would be clearer in the results if maybe would be more explicit or add some icons on the PCA

In our current study, we have no small plants, only trees. We are therefor also not sure how icons will help.

Line 329-333: which result are you referring to?

This seems to have been an omission; it has now been removed.

Line 335: "stature-recruitment trade-off" this is the first time that this is mentioned

This has now been included in the expanded introduction. See remarks above

Line 347-350: I haven't seen this in the results. You refer here to supplements... main results should be placed in main. Note that this seems main as you started the paragraph with this. Same for the correlations.

We have rephrased this now in the new version (Line 363...)

Line 377: those are results.

Yes, they are indeed but these are from another study and hence should not be placed in the results section of our study. (line 417)

Line 400-462: this is intro. It can be more concise and added to have a good background of this study. The specific traits, processes can be placed, for instance, in a box.

Agreed, most of it went to introduction. The traits are (and were) discussed in Suppl. Box 1.

Line 464: this wasn't introduced before. How does this relate to your questions? How was this analyzed? and what are the outcomes?

Agreed, It was only mentioned in one sentence (Line 108, old MS.) We have now added a few lines to introduce this important topic (Line 180 – 183).

It has been analysed in a similar fashion as SB, pH, Annual rainfall and CWD. See Fig 2, Suppl. Fig 4 e-f, Suppl. Table 2c)

Conclusions:

We have removed the conclusions.

Methods

Line 540: are these nested in the genus-level plot ones, or are they different plots?

They are nested. We made that clearer in the text now (Line 518 – 522)

Line 548: add "species-level" before "plots"

This should actually be genus-level and we have now updated the sentence (Line 530)

Line 554: specify which traits you used and to which spectrum they relate.

Most of that is in Supplementary box 1, we are referring to that now.

Line 563: there is only one map in the main text. Specify

This also pertains to all maps in the online supplement, see line 575.

Line 578: what was the coverage for height?

There is no coverage of height data, which is also specified in L563 in the revised version.

Line 589: replace ATDN for forest plots, do not complicate the reading on purpose.

We do not mean to complicate on purpose. The first author has written so much on inventories from the Amazon Tree Diversity Network that this has become almost an automated phrasing, we have now remedied this.

Line 591: a spatial model of what?

Of each trait, this has now been added (Line 575).

REVIEWERS' COMMENTS:

Reviewer #1 (Remarks to the Author):

The authors had done an excellent job of addressing the reviewers' comments. In particular, I appreciate the effort the authors put in to expanding the introduction.

Line 91: change less to fewer

corrected

Line 109: increase

Increased, corrected

Line 113: would this be increases with soil fertility?

No, mean seed mass is higher in areas with low fertility, enhancing survival in low dynamic environments.

Line 122: maybe clarify that it's a do-it-yourself strategy for acquiring resources or outsourcing strategy that relies on fungi

Done – lines 122-123

Line 146 What does observed much earlier mean?

I have added Swaine & Whitmore 1988 here

Line 231: is 44% correct, using later PC axes explain less of the total variation

Thank you for noting this. This was not worded correctly. The 44% is how well the single trait explains the axes. So, if the axis explains 20% of the data and a trait 40% of the axis, it explains 8% of the data. I have corrected the wording for one more instance and in the tables in the online supplement.

Line 619: The statistical analyses undertaken should be added here, even if brief. What R package was used for PC analyses, what package for Mantel test, etc?

Again thanks. This somehow disappeared from the text.

Reviewer #2 (Remarks to the Author):

I congratulate the authors for their excellent work! The manuscript has significantly improved and is now much easier to follow. The removal of abbreviations is well done. The abstract is straightforward and to the point. The introduction is now well-explained; I've learned much from it. Using subtitles in the discussion provides a clear structure, which is nicely done. Below are a few small minor comments and suggestions:

Line 87: Please specify that this is the seed size-seed number tradeoff.

Added in current line 91

Line 132: Add a brief sentence explaining the relevance of Aluminium accumulation.

Added in lines 136-138

Line 141: The sentence "Thus, under favourable conditions, plants will show traits that allow them to grow fast and to compensate for herbivory, but at a cost of being more weakly defended against herbivores" is a bit unclear. Are plants growing fast to compensate for herbivory, or do they compensate differently? If so, how does this make them weakly defended? Clarifying this point will help avoid potential misinterpretation.

I have done this in lines 145 - 147

Line 513: In the sentence "vegetation models and earth system models such as 104, and105," it seems like the model names are missing. If you are referring to specific authors, perhaps add the names of the models for clarity.

Both cited papers discuss general models but I have arranged the sentence so that the type of models are now cited by their own reference