

Comments from referee 1 (in blue)

In this manuscript the authors describe the results of a large manipulative experiment where multiple tree species were planted at three different elevations in order to observe the effect of temperature change in their growth and mortality. In addition, these species represented different successional strategies (Early and Late) and different forests of origin (montane vs transitional). I find the experiment very impressive. The manuscript is very well-written and presented so I want to congratulate the authors. I do however, think that the story is quite complicated and the constant use of acronyms does not help to simplify it. The intro needs a few adjustments to make it shorter and more concise (see below) but it is on the Methods/Results and Discussion where it gets harder to follow and stay engaged. These are a few suggestions to make the manuscript more engaging:

- o Try to reduce the number of acronyms or modify the current ones for something more explicit, for example: LVTF- Transitional forests, TMF – Montane forests; ES- Early-S, LS- Late-S
- o Include a diagram that explains the experimental set up with the three elevations, species origins, data recorded (could be in Supplement)
- o Include a summary figure with your main results. The figures (for example fig.2 and 3) have a lot of information and it is hard to focus on what is important and what does it mean.

Something that I do not understand is the role of the higher elevation site as the control site. That is mentioned in the methods but I do not see much discussion around this fact.

The title undersells the study. That could be the title for an observational study. I think it should reflect the enormous experimental work and novelty of it.

Response: Thank you very much for appreciating our study. Thanks also for all constructive suggestions for improvements.

We will try to reduce the use of acronyms in the revised manuscript. We will also try to construct a diagram explaining the experimental set-up for the supplement or as a graphical abstract. We agree that Fig. 2 and 3 have a lot of information, but we have tried to synthesis this information in Fig. 5, 6 and 7 so we believe that additional figures are not needed. The reference to the highest site as the control site is accurate for the species originating from montane rainforest; for these species the other sites represent a warming scenario. For the species originating from transitional rain forest it is not that simple. We will revise to more clearly acknowledge and discuss this matter. Thanks for suggesting a stronger title. As a revised title we suggest: Thermophilization of Afromontane forests demonstrated in an elevation gradient experiment.

Some line comments:

Abstract

Very well written. The only doubt I have is at what stage where the plants transplanted (seedling, sapling...)

Response: It was seedlings (except for one species for which cuttings were used but in a "seedling size"). We will add this information in the abstract.

Introduction

45- negative effects on xxxx and where?

Response: Thanks for the comments, we will add this information: *“...warm and dry conditions during El Niño years have caused negative effects on tree growth in Central America, Amazonia, West and Central Africa and South-West Asia as well as increased tree mortality in Amazonia (Clark et al., 2003; Lewis et al., 2011; Rifai et al., 2018).”*

50 - in the field? Need to be more specific, In mountains heat and drought do not always covary

Response: We will remove *“in the field”* as it may confuse, and more clearly point out that heat and drought not always covary by changing this sentence: *“However, due in part to common co-variation of heat and drought, the direct effect of warming on tropical forests remains unclear”*

59 – Large variability... This sentence is unclear needs to be reorganized.

Response: We will revise the sentences as follow: *“Large variability across studies and species has been observed, from positive to negative effects (e.g. Slot & Winter, 2018; Dusenge et al., 2021; Wittmann et al., 2022). This may reflect large variation in species origin temperature zone and how this compares to experimentally applied temperature treatments, with positive effects being more likely if origin climate is rather cool and the warming treatment is modest.”*

64 – You may want to read Tovar et al 2022

Response: Thank you for bringing this recent publication to our attention. We will cite this to support the statement on line 64.

65 – The lower elevation limit of TMF varies widely between and within continents so I am not sure what this >1000 m a.s.l. refers to

Response: We agree that the TMF elevation limit is highly variable. However, most estimates of their area globally are based on a general lower elevation limit. We think it is important to give the reader an idea of the extension of such forests so we used and relatively recent estimate from Spracklen & Righelato, 2014 who used 1000 m a.s.l. as a limit. Here is preliminary modification of the text to clarify this: *“TMFs occur at all continents within the tropical biome. The lower elevation limit varies widely between and within continents, however, by using a general lower limit of 1000 m a.s.l., the cover has been estimated to 8% of the total tropical forest area (Spracklen & Righelato, 2014).”*

70 – why species on the higher elevations are further away from their thermal optimum? You imply that they could tolerate a higher increase in temperature than lower elevation plants, but you need to justify that. For example, Leon-Garcia and Lasso 2019. Although here they go all the way to the paramo ecosystem.

Response: We agree that this statement should be justified by a citation. Thanks for the suggested reference, but we think that Feeley et al 2020 in *Frontiers in Forests and Global Change*, better support this statement so we will add that reference.

83-90 The intro is great until this paragraph. I think it is a bit repetitive, and there is one minor point that could be made more clearly and briefly. Maybe as a first line of the next paragraph a sentence linking the functional strategy with different chances to survive and then growth forms?

Response: We agree that this paragraph is a bit redundant and suggest to removing it completely.

o I am more familiar with using ES and LS to refer to species but primary or old-growth and secondary forests to the forests. I think better to keep them separate.

Response: We agree that primary and secondary forests are more commonly used and we will change to this terminology in the revised version.

o I don't like the sentence: remains uncertain. is it the forests? The species?.

Response: We agree that this is unclear and we will change this sentence to: *"However, it remains uncertain if the ES species are winners or loser in a future climate, and thus if the expansion of secondary forests will be amplified or not."*

o Also, these experimental indications – how are they different from what you are doing here? Are they greenhouse experiments, models? Better to indicate so you can highlight the novelty of your paper.

Response: Thanks for this suggestion. We will to add a sentence that these studies either only included few species representing ES and LS strategies, use artificial heating in chambers or infra-red heaters or only have looked at physiology

100 – defining ES species here is a bit late, should come at the beginning of the paragraph.

Response: We will move the text about fast and slow growing species to the beginning where ES and LS species are defined as acquisitive vs. conservative species.

100 – suspectable= susceptible? Susceptible

Response: Thank you for spotting this typo. It should be susceptible.

Overall, this paragraph also needs some reorganizing and trimming

Response: We think that the paragraph is mostly good, but as said above we will move the information about slow and fast growing species to the first part.

105-115. This seems like a good point but is it important enough to be a whole paragraph? I think the intro is really long and this is something that you should cut.

Response: We think it is an important point, but we will try to make it shorter in the revised version

116 – I feel now we are back on track. This brings the story back to line 81 – I would probably talk about the growth strategies after this paragraph or even after the next one where you explain your objective. The reader needs to know early on the intro what you are doing on the manuscript, and it is not clear until here.

Response: Thanks for the suggestion, we will consider moving the growth strategies to after this section.

125 – identical plant material- not sure what it means

Response: We will change this to *"genetically similar plant material"*

129 – at what stage are the trees transplanted? Saplings?

Response: The plants were in seedling sizes when transplanted from a central nursery (at the mid elevation) to the sites but most species developed quickly into sapling sizes at the sites, while a few stayed in a seedling size for quite long time. We prefer not to explain this in the introduction as it

may complicate the overall message of the design. Instead, it is well described in the material and methods as well as in the Table S1 of the supplement.

135 – are lower elevation species planted on even lower elevations? I get that from the hypothesis. Maybe include the elevational range of the species in the objective?

Response: The lowest site is below the “transitional rainforest” category so we would say YES, there is a warming treatment for all species. For some species, the distribution range covers the lowest site, but dominating distribution is from the “transitional rainforest” area. We will revise to make this clear already at the end of the introduction.

Overall, I would reduce the background information on precipitation and drought because now I realize that you are irrigating to isolate the effect of temperature, so better to focus on that.

Response: We believe that it is important to give background information about both drought and temperature as they are closely connected. In our case the soil drought effect is small (expect the 2019 drought period) while still there is a VPD effect. I don't understand this comment as it seems related to the introduction.

Methods

150 – increased/decreased by

Response: This will be changed accordingly

159 – I don't understand why that site is the control at 2400 because the species grow nearby at (potentially) 1600m which is as low as the mid-elevation site.

Response: As pointed out earlier, we will remove this statement to avoid any confusion.

In Table 1 PNV of HE should be the full name to make it easier to link with the text (TMF)

Response: This will be changed accordingly

224 – I do wonder about the effect of solar radiation. The HE site is thus the control but also the more shaded one.

Response: Yes, solar radiation is slightly lower at the HE site, This is clearly mentioned in material and methods and possible effects of radiation is discussed on line 491-496.

It is overall a bit confusing the species origin vs the planting sites. And where is the control evaluated?

Response: As indicated above, we will revise to more clearly acknowledge and discuss this matter. As mentioned earlier we will remove the statement about control as the results not has been specifically analysed in relation to a control.

Results (see comments above)

Discussion

405 – This drought period, was it a problem with the irrigation system? Has it been mentioned before? can it have an effect on other variables?

Response: On line 179-181 it is mentioned: “while all plants were exposed to the dry period from mid-July to end of August 2019.” The drought in 2019 was therefore intentional and not linked to a

problem with the irrigation system. As mentioned on line 221-222, the relative seasonal distribution of precipitation was similar at all sites, and the 2019 drought should therefore have only minor effect on growth between sites. However, we will address this more clearly also in the discussion in the revised version.

467 – Transplant experiments are also a good approach for this and should not be ignored (e.g. Tito et al 2020) but may be limited to one or few species.

There is also a lot of work into temperature sensitivity measured as leaf temperature tolerance and safety margin. I would change a bit the phrase to be more specific to what you want to say.

Response: We state here that current knowledge is “primarily” based on observational studies controlled warming experiments. Transplant experiments is essentially the same as the Rwanda TREE approach (but at smaller spatial scale), and since these studies are very few for tropical trees they do make up a third body of evidence and thus do not qualify into this sentence. With respect to leaf level temperature studies, these are either part of observational or controlled experimental studies and thus do not conflict with the current wording. To justify the choice of references we will reword to “...temperature sensitivity of tropical tree growth...” at the beginning of the sentence.

477 – pattern was or patterns were

Response: Thanks for spotting this, it should be “patterns were”.

482 – Moreover, other studies in the photosynthesis of Rwandan forests showed...

Response: Thanks, the text will be changed accordingly.

531- the mortality driven thermophilization is a mechanism at the community level. This study calculated the Community thermal index using the species optimum temperatures and their relative basal areas, and then its change through time. A change in CTI is easier/more obvious by the mortality of large trees than by the addition of new ones given their effect of the relative basal area. So I would not necessarily think that it is a big contradiction to your results of mortality per se, they are different approaches.

Response: Both growth and mortality contribute to the basal area-weighted index used in this study, but there is no “addition of new ones” since we planted seedlings. It is therefore true that our approach differs from previous studies (Fadrique et al., Duque et al.), but still lack of statistical difference between the two origin elevation groups is contrasting with their findings.

537- Amazonian plots with tropical forest? Not sure why the explanation, is this for the Australian plots?

Response: This sentence refers to two different studies, one on plots in Australian tropical forest and another in plots of Amazonian forest. Note that the first study mentioned in the Amazonian forest (line 534-536) is different from the study mentioned on line 537.

Fig S1, S2 ,S3- I think you should mention here that the irrigation/nutrient experiment only started in 2019-9 and it had no effect on your results - to remind that it is not a variable taken into account in the manuscript

Response: Yes, we will give this information also in the legends of Fig S1-S3.