1. Post-revision response to reviewers: egusphere-2025-2032 *Oelkers et al.*

We thank the *Biogeoscience* reviewers and the editing team for their constructive feedback which has greatly improved the manuscript *Radial growth decline in a tropical Andean treeline in Bolivia* (egusphere-2025-2032).

In addition to the updated point response on **page 3** (**1_PointResponse**), the revised manuscript (**2_Clean**), and the original manuscript with track changes (**3_Trackchanges**), we have generated a new Appendix of supplementary figures (**4_AppendixA**) and uploaded an excel file of the updated *P. pepei* tree-ring chronologies to 'Assets' (**5_Ppepei_RW**). Major updates to the manuscript include:

1.) The addition of a new co-author: Dr. Hung Nguyen from the University of Illinois-Urbana Champaign
2.) Reorganization of the Introduction & Discussion
3.) Generation of aerial map of sampling sites and summary table of site statistics
4.) Improved sample size and length of the RW chronology (31 trees, 1850-2018; prior: 28 trees, 1868-2018)
5.) Updated climate analyses, and the use of a new precipitation dataset (correlation period is now between 1960-2015 instead of 1981-2018)
6.) Updated all figures and created an Appendix for supplementary materials (**see summary on page 2**)

Our results and interpretation remain the same after updating the analyses with the improved chronology (i.e. higher sample size) and new climate data set (i.e. higher resolution), confirming previous analyses. We present a ~170 yr record of annual tree-growth of *Polylepis pepei* from a tropical treeline in Bolivia. In recent decades, the ring-width is adversely affected by rising temperatures and a decrease of precipitation during the peak wet-season. Our results show these trees retain information from extreme drought events related to El Niño, and large-scale hydroclimate variability patterns in tropical south America. The observed decline in radial growth for *P. pepei* is of great concern for this temperature-limited treeline that is experiencing significant warming and a water-stress during the growing season. Overall, we feel strongly that this record provides new in-situ information regarding the age, growth, climate sensitivity of a tropical treeline that wasn't available previously.

For transparency, the list of figure updates is listed below.

Main text

Figure 1. **Site description**: new climatology (1960-2015; B) and site map (C)
Figure 2. RW chronologies: Raw Rw from open/closed forests (A), updated standard and residual chronologies (A-C) and sample size (now on C), clear labels for percentile years (D)
Table 1. Chronology statistics summary
Figure 3. Monthly climate correlations: New precipitation (Pre) dataset and time period for analyses (1960-2015 instead of 1981-2018)
Figure 4. Spatial correlation maps: now Tmax, Tmin (1960-2015) and CHIRPS precipitation (1981-2015). Seasonal climate was inferred from monthly correlations (note older Seasonal correlation plot was removed)
Figure 5. SEA for ENSO events: analyses was updated and figure quality improved

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Appendix A (new, after Conclusions)

Table A1. List of ENSO years (used to be in methods with SEA analyses**)**
Figure A1. Monthly climatology of Tmax, Tmin, DTR
Figure A2. (old Figure 2) **P. pepei photo, radiocarbon, and anatomy.** (New photo of whole tree)
Figure A3. Daily Relative Humidity and Tmin and Tmax from dataloggers (mean Temp and RH plots have been removed)
Figure A4. Seasonal climate trends for Tmax, Tmin, Pre, and Tavg (1960-2015) (new)
Figure A5. **Annual and seasonal (wet vs. dry) trends of DTR anomalies (1901-2015).** Monthly Tmax and Tmin anomalies (1901-2015) are also included.

Thank-you again your consideration of this manuscript for the Special Issue of *Biogeosciences:* "Treeline ecotones under global change: linking spatial patterns to ecological processes". We hope we have addressed your major concerns during the revision process. Specific point-by-**point responses are included below on page 3**.

Sincerely, on behalf of the co-authors,

Rose Oelkers

November 24, 2025

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Point by Point response to reviewers

1.) We have numbered the original suggestions by RC#1 from 1-4 and RC#2 from 1-35
2.) Author responses are in **black bold "Times New Roman" text.**
3.) Relevant text from the manuscript *is included in grey-colored italics.*

Referee Comments #1

1. Line 116-121: This paragraph move to after of line 81.

This was in reference to the Introduction paragraph starting with:
Old L116 "The geographic range of Polylepis pepei (family Rosaceae; common name "Kenua" or "Queñoa") spans from central Bolivia to northern Peru (Simpson, 1979) between 3550-4800 m.a.s.l…."
To be moved after the paragraph old L81:
Here we describe a tropical treeline site of Polylepis pepei BB.Simpson (Simpson, 1979), growing high elevations (3700 -4000 m.a.s.l.) in the Andes-Amazon corridor of Bolivia in South America

This was a useful suggestion during the process of re-writing the introduction. This change has been made.

2. Line 149: Add a table with the information of sites and samples.
This was a great point to make. We made three main changes:
1.) generated an aerial map of site locations in Figure 1C,
2.) added text in methods section 2.3,
3.) and included a new summary table in results that corresponds to the updated figure 2A of chronologies.

We would like to emphasize here that the RW chronology represents the entire network of *P. pepei* (open and closed canopy forests), but we acknowledge that the original wording during the chronology development section (old methods section 2.4) may have made that unclear. We hope these changes have remediated the issue. Lower resolution images of updated Figure 1 (Methods section 2.1), Figure 2 (Results section 3.1), and the new table (results section 3.1) are included below (for context.

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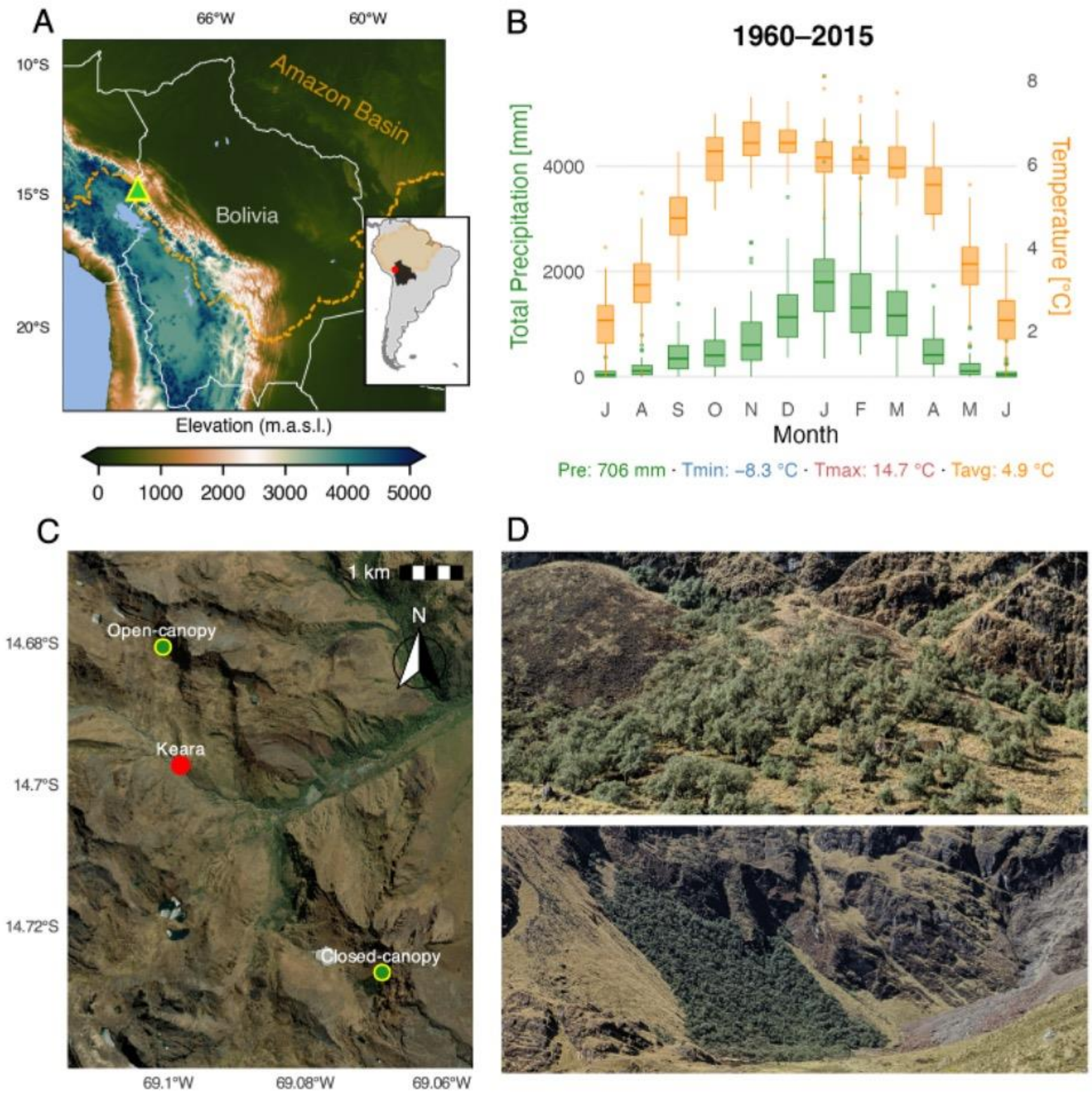

Figure 1: (A) Location of Polylepis site in the Eastern Cordillera of the Andes-Amazon ecotone in Bolivia. The orange dotted line (and orange shading in the inset map) represent the spatial limits of the Amazon Basin. The elevation map was generated using the "ETOPO-1" model (https://www.ncei.noaa.gov/products/etopo-global-relief-model; (B) The monthly distribution of mean temperature and total precipitation (1960-2015) in Keara was generated using the nearest temperature CRU gridpoint (14.75°S, 69.5°W) and reconstructed precipitation from the Italaque station (15.48°S, 69.03°W). The average temperature (Tavg), mean precipitation (Pre), and range of minimum and maximum temperatures (Tmin, Tmax) for the study period are included. (C) Aerial view of the sampling locations near the community of Keara and (D) photos of open-canopy and closed canopy forest patches sampled at altitudinal treeline in Bolivia's MNP (~3700-4400 m.a.s.l.). The basemap in (C) was obtained through opensource ESRI images.

Site	**Location (elevation)**	***n* trees (*n* samples)**	**Mean age [yrs]**	**Timespan**	**Mean RW Correlation**	**Mean DBH [cm]**
Open-canopy forest (south-facing)	14°40'S 69°06'W (3795-4100 m.a.s.l.)	16 living 2 dead (33)	89	1850-2018	0.53	24 cm (*n*=6 trees)
Closed-canopy forest (west-facing)	14°43'S 69°04W (4000-4400 m.a.s.l.)	12 living 1 dead tree (18)	101	1871-2018	0.44	31 cm
Full network (mean Raw, standard, residual chronologies)	-	31 (51)	93	1850-2018	0.50	30 cm

Table 1. Summary of P. pepei tree-ring sample location, age, sample size, and mean correlation of RW timeseries per site. *DBH information is only from the samples collected in 2019 which included 6 trees from the open-canopy forest and 13 trees from the closed-canopy site. The final RW chronologies represent the entire collection of P. pepei samples in Keara obtained in both 2012 and 2019.

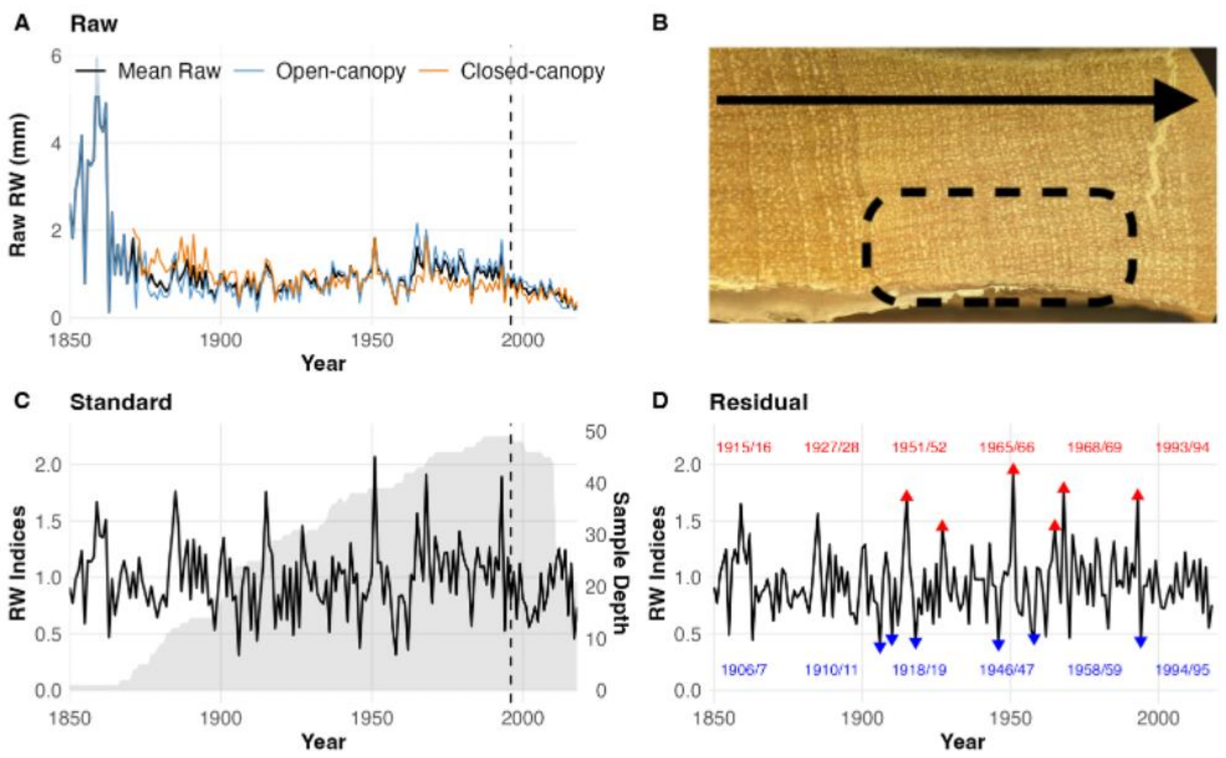

Figure 2. The (A) Raw (C) Standard and (D) Residual RW chronologies of** P. pepei **in Keara. The chronologies (1850-2018) are plotted using the Schulman convention (i.e., anchored on the year of initial ring formation; see section 2.3). (A) There has been a distinct decline in raw (radial) RW since the 1996/1997 growth-year (changepoint is indicated by the black-dotted line. (A) This decline (p=0.01) was evident in both the open-canopy (blue line) and closed-canopy (orange line) forests that were sampled. (B) An image depicts a core sample where several rings are suppressed within a 4 mm distance (dashed circle). The black arrow indicates the direction of radial growth for this core (from left to right). (C) The standard RW is plotted with the mean sample-depth of the full network through time (grey-shading). Triangles on the residual timeseries (D) signify the years within the top 5th (six smallest growth rings; Blue color) and 95th (i.e. largest growth rings; red color) percentiles of RW since

1900 (SSS> 0.85). Since the tree rings are estimated to form during the wet season (two-calendar years ~October-April), both years are labeled in the colored text (ordered chronologically).

3. Line 295: “Notable growth” change to Extreme growth.

> **Thank-you we have updated this sentence at the last section of (section 3.1) as follows:**
> *“Years with extremely large RW (95th percentile) included…”*

4. Line 309-310: Delete sentence. The next sentences repeat the same.

> **Thank-you for your time and suggestions. The results section for the monthly correlations (section 3.2) has been re-written.**

Referee Comments #2 (1-4)

1. Authorship: the 'Author Contributions' section does not list all authors. Please revise this section and check the grammar throughout.

> **We appreciate the reviewer’s observation and have updated the grammar and flow overall.**

Abstract

2. The first sentence mentions tree growth dynamics over “a few centuries and present,” yet the study focuses on the past 40 years. Please revise it.

> **Thank-you for pointing this out. This sentence has been removed during the revision phase of the Abstract.**

3. Avoid unnecessary acronyms, e.g., delete “RW” for ring width.

> **We have removed all acronyms in the abstract**

4. Terminology: please be careful with word choice, e.g., “shift in tree-ring width” (line 39), “common radial growth” (line 42).

Thank you for this suggestion. The Abstract has been updated for clarity.

5. Lines 24–25: I suggest moving the phrase "a trend that mirrors a decrease reported in other Polylepis" to the end of the sentence "...tropical Andean treeline, shows a recent decline...".I recommend removing the data logger results from the Abstract, as these are weak given the data quality.

> **Thank-you for the suggestions. We have removed the dataloggers from the Abstract and the figure (included below) is currently moved to the Appendix A: Fig. A3. We agree the data covers a short time span, but we would like to highlight that this is the first high-resolution (hourly) climate record in the region and provides unprecedented information regarding the local time of peak temperatures and humidity (see Discussion section 4.2). The results provide 4-years of wet-season temperature and humidity variability in the tropics where station data is geographically sparse and low quality. The process of installing and recovering these instruments during the field campaigns involved immense travel-time from La Paz and significant resources. We believe this data is valuable to the community and our hope is to upload this data to a public repository in the future.**

Introduction

6. Please consider restructuring the Introduction. My suggestion is to start with tropical treelines in the Andes, then the main species, especially P. pepei, the disturbances (anthropogenic and climatic), and finally the previous dendrochronological studies in similar areas.
7. Lines 37–49: Remove the discussion of Northern Hemisphere treelines; it is misleading, and references are outdated.
8. Line 39: Clarify what is meant by "shifts in tree-ring width have been linked to upward recruitment."
9. Line 53: Specify why tropical treelines, more than other ecosystems, are of great concern, and explain the link with anthropogenic influences.

> **#6-9:. The northern hemisphere treeline discussion has been removed, and the Introduction reorganized to reflect tropical Andean treelines, the impact of warming, and the value of high-resolution information of tree-rings and disturbance near Kera. The sentences referenced above for L65 has been removed.**

10. Line 65: Clarify the use of the term "timberline."

11. Lines 69–72: Add the time period of the correlation analysis and discuss how your results compare to Morales et al. (2004) in the Discussion.

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This was a great idea. The time period for P. tarapacana climate analyses in Morales et al. 2004 (1934-1980) was updated in the Introduction paragraph about tree-line tree-ring studes. Additionally we have added the following sentences to Discussion Section 4.2:

We found that P. pepei RW is limited by prior-year temperature and precipitation variability during the wet season, with larger RW in the subsequent growth year when it was wetter and colder (Figs. 3 and 4). This is consistent with previous tree-line studies showing Polylepis ring-width positively correlated with previous growing-season water availability (Argollo et al. 2004, Morales et al. 2004, Christie et al. 2009, Soliz et al. 2009, Crispín-DelaCruz et al. 2022, Rodriguez-Caton. et a. 2021).

12. Line 78: Clarify what "respectively" refers to.

This needs to be rephased for clarity. For context I have included the original text from L78 here:

In the temperate Nothofagus pumilio (Poepp. & Endl.) Cuatrec. Andean treeline, temperature variability facilitates tree recruitment in northern and southern Patagonia, while the rate of seedling establishment can be strongly modulated by the interaction between temperature and precipitation driven by the Pacific Decadal Oscillation and the Southern Annular Mode, respectively (Srur et al., 2018, 2016).

We have re-written this:

Seedling recruitment of *Northfagus pomillo* **is driven by temperature variability, the rate of seedling establishment was limited by overall moisture conditions in Patagonia.**

13. Line 83 and elsewhere: Standardise the expression for meters above sea level ("m asl" or "m a.s.l.").

This has been updated

14. Lines 84–85: Add the link to Figure 1 in the text.

15. Lines 93–94: Avoid acronyms that are not used later (e.g., TNA, TSA, MNP).

#13-15: This will be reviewed and corrected in an updated version.

16. Lines 96–98: Rewrite for clarity; the current sentence is vague and overly complex.

This can be shortened for brevity and combined with the second sentence. The main idea is: Complex topography in the Andes-Amazon region contributes to diverse rainfall and vegetation gradients. Due to the local orography, it is difficult to tease out the influence of large-scale hydroclimate patterns on regional tree-growth.

17. Lines 108–112: Consider whether these sentences are relevant.

These lines have been removed during the rewrite of the Introduction

Materials and Methods

18. Lines 129–131: Rewrite for clarity and avoid repeating "dendrochronological" twice.

Thank-you, the grammar has been updated

19. Lines 134–140: Clarify if two different climate datasets were used for temperature and precipitation, whether they were compared, and if the climate–growth correlation was conducted for the same period.

We apologize for the confusion in the first manuscript. The text in section 2.2 and 2.4 has been updated with to provide further details and we hope it clears up the confusion on the datasets used, and their timespans.

In Section 2.2. we discuss the new precipitation index reconstructed from nearby stations ('Pre'). This has allowed us to extend the <u>monthly</u> climate-growth analyses to the 1960-2015 period.

CHIRPS precipitation was still used for spatial analyses (1981-2015; see below). andCRU TS v.4.08 was used for temperature variables (Tavg, Tmax, Tmin, DTR 1960- 2015)

Due to extremely significant and adverse effects of temperature on *P. pepei* RW at this treeline, we used the local CRU gridpoint to evaluate the monthly climate anomalies of Tmax and Tmin between 1901-2015 (see Appendix figure A5). 1901 represents the earliest date provided by CRU, and we truncated until 2015 to remain consistent throughout the manuscript. We also plotted annual and seasonally averaged DTR for this period. The goal was to show long-term temperature variability a region that is undergoing significant warming in recent years.

To provide further context we used:

- **Hourly (resampled to daily) data from the data loggers**
- **<u>Monthly climatology & seasonal climate trends 1960-2015:</u> Climatology figures (Fig. 1B, Fig. A1), climate *trend* analyses (Figs. A5 and A6), and monthly RW-climate correlations were conducted from 1960-2015.**

- **<u>Spatial</u> RW-Temperature correlations (Fig. 3BC, Tmax and Tmin) were between 1960-2015, but spatial precipitation correlations (CHIRPS) was for the period 1981-2015. As stated in Section 2.1 CHIRPS is more effective than CRU for spatial precipitation analyses in regions with complex topography such as our site in the Andes-Amazon. Temperature variability is more uniform across these regions of tropical south America which is why we used CRU temperature for spatial analyses.**
- **<u>Longterm variability of temperature anomalies 1901-2015 (Fig A5)</u>**

20. Lines 183–188: Move this ecological description of P. pepei to the species ecology paragraph.

This is in reference to the following text now in Methods Section 2.3 :

To aid in identifying anatomical properties in the wood, histological (micro) cuts were performed according to techniques described in von Arx et al. (2016) using a WSL Core microtome (<u>https://www.wsl.ch/en/services-produkte/microtomes/</u>). P. pepei is an angiosperm with diffuse porous wood anatomy, which is typically harder to date than 'ring porous' wood, due to less distinct boundaries between the latewood of the prior year and the earlywood of the current year. P. pepei tree rings feature large, semicircular vessel elements in the earlywood that taper tangentially in size towards the transition to latewood, which has thicker, fiber-like tracheid cells (Fig. 2B; Roig et al. 2001).

This was a good point. We realized the citation of *Roig* et al. not necessary here as it is a generic description of wood based on our anatomical analysis (now Fig A2 B; see response to #21), so the citation has been removed. However because this text describes wood processing after the field and was an integral step in annual RW chronology development, we decided to leave the text in this section (2.3).

21. Figure 2: Add a photo of the whole plant. If possible, compare phenological and growth differences between the open-canopy south-facing slope and the closed-canopy west-facing slope.

We have updated the photo in old Main text Fig. 2 (now Appendix fig. A2) to include the whole tree photo see below:

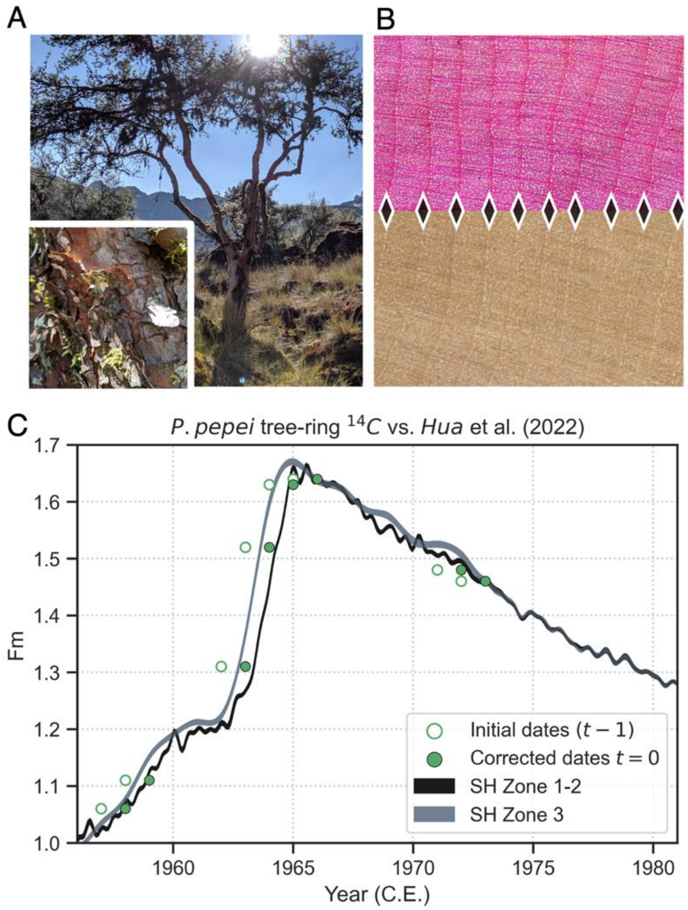

Figure A2. (A) Photo of a P. pepei *tree in Keara. The bark consists of thick layers of compressed flakes that are red and brown in color, characteristic of the genus. (B) P. pepei wood anatomy shown as a histological slice and scanned image of a tree-core. The direction of growth for the sample is from left to right (pith to bark) while diamond shapes indicate the latewood/earlywood boundary between annual rings. (C) Radiocarbon measurements (green circles) from the alpha-cellulose of selected rings in a cross-section is plotted with the [a]Hua et al. (2022) reference curves SH Zone 1-2 and SH Zone 3.*

22. Line 214: Check the reported correlation values. Consider omitting the section on chronology correction, as the issue appears not to be ring detection but miscounting an incomplete ring, if I understood correctly.

Thank-you for this suggestion. The following paragraph (old L 214) was moved from the 'chronology development section' to the Appendix with Fig. A1. and simplified. Also, to clarify any confusion the 2012 samples that were measured previously (KEPP) were only used as a reference while crossdating the RW from 2019 samples. The 'end date' for the original dataset was improperly assigned to 2010/11 when it should have been 2011/12. Although it may be out of the scope of this paper- we think it's interesting to share with the community that only certain cores had partial wood formation for 2012/13 because it likely relates to the eccentricity of radial growth for *Polylepis*. Roig et. al (2001) also observed this in *P. pepei* core samples from Cochabamba Bolivia, which leads us to speculate if there may be differences in the timing of xylogenesis at the tree-level during the growing season.

Updated text from old L214, now in Appendix A, with Fig A2 :

At early stages of RW chronology development for the Polylepis pepei network, initial radiocarbon results (Fig. A2C) showed that ^{14}C measurements of SP20X were offset by 1 year in relation to the SH Zone ^{14}C curves. In the original P. pepei RW data generated with material collected in October 2012, the last ring (assigned as 2012) was not measured as it was considered an incomplete growth year. Upon a recent inspection of these samples, we observed that the final ring behind the bark did not always correspond to a partial ring as some trees had not yet started wood formation in 2012 (at least for the side of the stem where the core was sampled). Therefore, the calendar year assigned to the last complete ring for the KEPP RW samples were measured and corrected to 2011. This date-adjustment on the (reference) samples from the 2012 campaign was confirmed after cross-dating RW from additional living trees collected in 2019 from the Waca-cocha closed-canopy forest. The final iteration of the Keara RW chronology (main Fig. 2), the 2012 samples (n= 18 trees) showed high correlation with the trees sampled in 2019 (n=13) indicating good agreement among all RW series for the Keara P. pepei network (combined mean correlation, r= 0.50). In summary, the traditional dendrochronological crossdating techniques of RW measurements, wood anatomical cuts, and radiocarbon results confirmed P. pepei in Keara formed annual rings.

23. Line 218: State whether the raw time series shows a negative trend.

We feel the identification of the negative trend in raw radial growth was best explained in results section. Thanks to your feedback, we plotted the raw data from both open and closed canopy sites (see page 5 here in response #4 to reviewer 1) where we see a gradual declining trend in radial growth since the 1960s, especially after 1996.

24. Line 219: Provide the number of samples from 2012 and 2019, distinguishing between living and dead trees. A table with tree status, age, interseries correlation, number of cores, and diameter would be useful.

> **This was an excellent suggestion. Please see our answer #4 Referee #1 for the newly generated Table 1 in results (Section 3.1). Although we do not have DBH data from 2012 fieldwork campaign, we made a table to clarify sample size, location, and chronology statistics. Most of the samples were living cores.**

25. Lines 219–220: Use precise terminology, did the authors "compare" or "correlate" with climate data?

> **We have updated 'compared' to 'correlate' for consistency.**

26. Line 223: Indicate which program was used to detrend the series.

> **We will add this. It was the "DPLR" package in R**.

27. Line 233: Specify the climate variables (temperature and precipitation) used and the exact period covered.

> **Great suggestion. As mentioned above in response #19, we moved all relevant climate information to section 2.2 when discussing climatology, with further details in methods section 2.4.**

28. Line 279/Table 1: Move this to the Results section. Clarify the years classified as ENSO events, why 13 years in each column, if there should be 24 years total?

> **Thank-you for pointing this out. This table has been corrected to reflect 13 individual years for El Niño and La Niña, and moved to the Appendix Table A1 for simplicity.**

Results

29. Lines 283–286: Ensure that methods are not presented here, and results are not in the Methods section.

> **We are including the original text for convenience (First line of Results 3.1):**
>
> *(L284) "The P. pepei RW chronology from northern Bolivia (max elevation 4400 m.a.s.l.) spans from 1868-2018 is shown in Figure 3. (L285) Wood anatomy confirmed the earlywood and latewood diffuse-porous features of the rings (Fig. 2B) and radiocarbon (L286/287) measurements (Fig. 2C) in selected years before and after the radiocarbon bomb-peak confirmed that the growth periodicity is annual."*

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We agree the confirmation of annual growth is not the main focus of this paper and thus (see response to #22). Section 3.1 has been re-written entirely for clarity.

30. Line 288: Provide more details on the dendrochronological suitability of P. pepei.

This is in reference to the following sentence in Results section 3.1 (old L288)

> *Due to extreme suppression in radial growth (Fig. 3B), only one or two cores per tree (out of 3-4 total) were able to be cross-dated and used for the final RW chronology.*

Thanks to your helpful feedback, we the updated Figure 2A (page 5 here) to include the raw RW from both sampling locations. We have also re-arranged the text in Section 3.1. to reflect the dendrochonological suitability which is determined by the inteseries correlation among series within the network and the SSS metric. The text below includes the updated text for this request and request #31.

> *Due to extreme suppression in radial growth (Fig. 2B), only one or two cores per tree (out of three total) were able to be cross-dated and used for the final RW datasets. A recent decrease in radial growth was observed in samples from both the open-canopy (18 trees) and closed canopy (13 trees) sites (Fig. 2A). The entire Keara P. pepei network (mean raw RW; Fig. 2A) has been declining steadily since the 1960s, especially after 1996 (p= 0.01), with a less pronounced trend in the standard RW series (Fig. 2AC).*
>
> *Despite difficulties with crossdating due to suppressed tree-rings, the entire network shared a coherency in the RW patterns with a mean inter-series correlation of $\bar{r}$ = 0.50 for the 1850-2018 period (n = 51 samples, 31 trees). The SSS metric indicated the common growth signal was particularly robust (SSS > 0.85) between 1900-2018 when the sample size was greater than 17 (Fig. 2C; average age of the trees 93 yrs). The average radial growth rate between 1850-2018 was 1.04 mm yr^{-1}. DBH measurements in 2019 (6 trees in the open canopy and 13 in the closed-canopy site), confirmed these trees were slow-growing with stem diameters ranging from 10 cm to 54 cm (mean DBH 30 cm).*
>
> *Years with extremely large RW (95^{th} percentile) included the 1951/52 and 1965/66 growth years (Fig. 2D) which occur before and after a visible growth suppression during the mid-to late 1950s (Fig.2 A, C). Tree rings that began forming in 1906 or 1945 had extremely low values of RW indicating unfavorable growing conditions during the growth-year.*

31. Lines 302–306: Correct the figure caption; the current "B" panel does not match the description. Reduce the font size of the legend in panel C. Clarify whether the pointer-year analysis covers a specific period. Discuss whether reduced sample depth (2012 vs. 2019) could explain the negative trend in the raw chronology and report the age distribution of samples.

We truly appreciate this suggestion because these requested changes have made our results more robust. As seen in Figure 2A both sampling sites consisted of trees sampled in 2019 (n=21 samples total). According to our SSS calculation (sub-sample signal strength; see methods section 2.3), the chronology was robust between 1900-2018 when there was a minimum sample size of 17 (section 3.1 results). We have updated caption of Figure 2 (page 5 above) to reflect the time periods of pointer-year/percentiles was conducted for this period, and the quality of this figure overall.

32. Figure 4: Make month labels more legible. Consider correlating the standardised chronology with the normalised diurnal temperature range (which shows a negative trend). Also, test correlations for November–February minimum temperature. Include seasonal correlations here and keep spatial correlations in a separate figure.

Thanks for the feedback. We have completely replotted the monthly and spatial correlation figures (now Figs. 3 and 4, included in page 16 below) that reflects the updated 1960-2015 analyses (included below) Seasonal climate windows chosen for the spatial correlations (including Nov-Feb Tmin) were inferred from the monthly correlations. The text in the results section has been updated to reflect this.

We have tested monthly correlations with DTR and RW (see preliminary analyses after the spatial figure below), however we felt the correlations between Rw-Tmax, and RW-Tmin was more informative than DTR (and even Tavg).

The monthly temperature sensitivity of this treeline *P. pepei* has distinct seasonality: There are negative correlations with prior-year Tmin and positive correlations with current-year Tmax variability Fig. 3AB. Further, there is a remarkable increase of Tmin during NDJF, and decrease of Tmax between 1960-2015. These diverging trends in climate, and the evidence that prior-year ~NDJFM humidity (Tmax, Pre) and current-year FMA tmax have unique influence on RW size, is why we feel RW-DTR- monthly correlations are unnecessary for this paper.

However, we do feel strongly about including the trends of DTR (1960-2015) anomalies with monthly Tmax and Tmin (1901-2015) in Fig. A5 that shows Tmin is driving the current DTR trends. Main figs 3 and 4, and Appendix figs A5 and A6 are included below with the preliminary DTR-RW analyses.

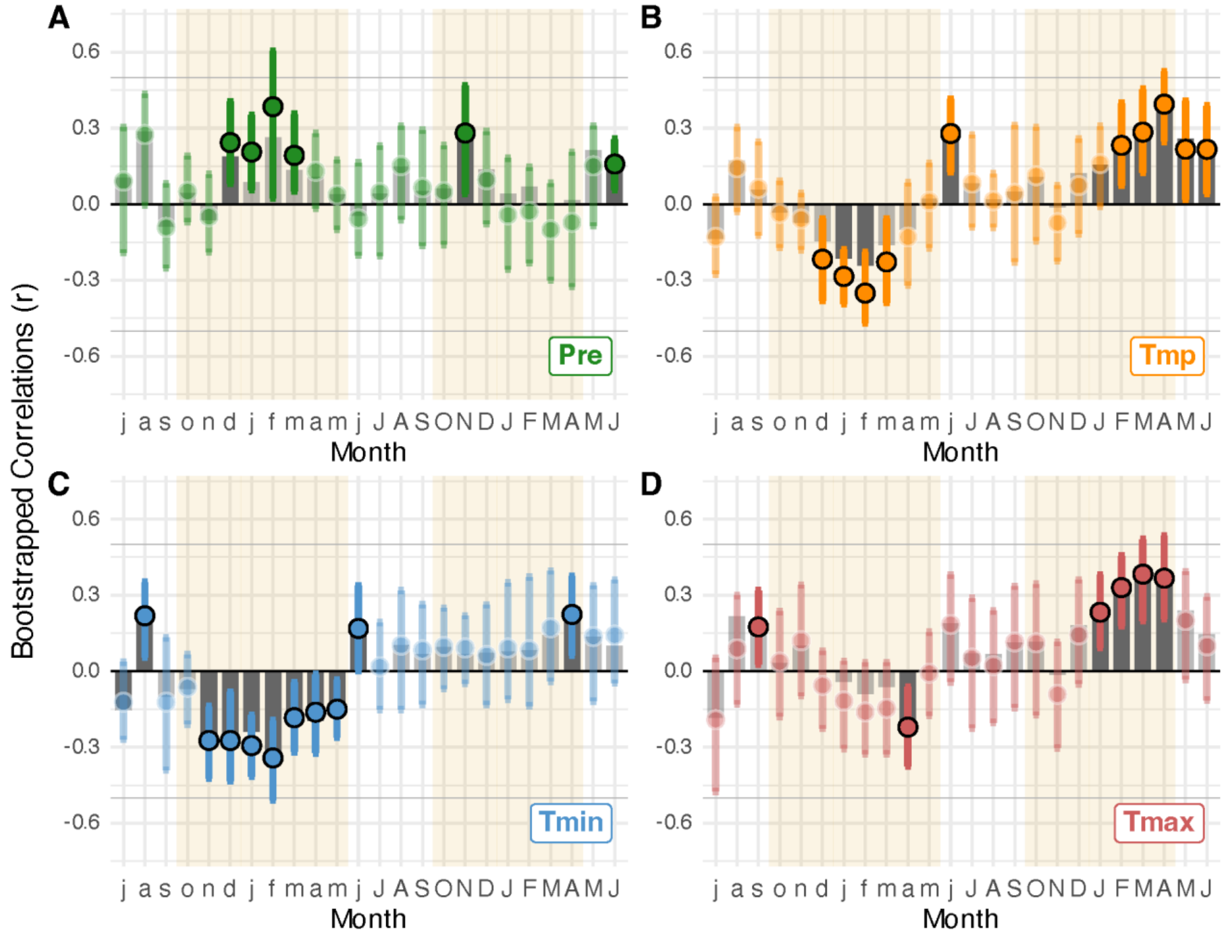


Figure 3: Bootstrapped correlations between P. pepei RW and monthly climate from 1960-2015. The x-axis represents months beginning in July of the prior-year (lag=1, lowercase letters) and extending to June of the current year (lag=0, uppercase letters). Tan shading indicates the extended wet period (~October- April) for this region of the MNP A: green color, precipitation from local station data. B-D: correlations with CRU temperature grid points Tavg(orange), Tmin (Blue), Tmax(red). The median Pearson correlation (r) is represented by colored circles plotted with upper and lower limits of confidence intervals. Partial correlations (r_p) are represented by grey bars. Solid circles and bars indicate significant correlations which are inferred from 95% confidence intervals from the random bootstrapping.

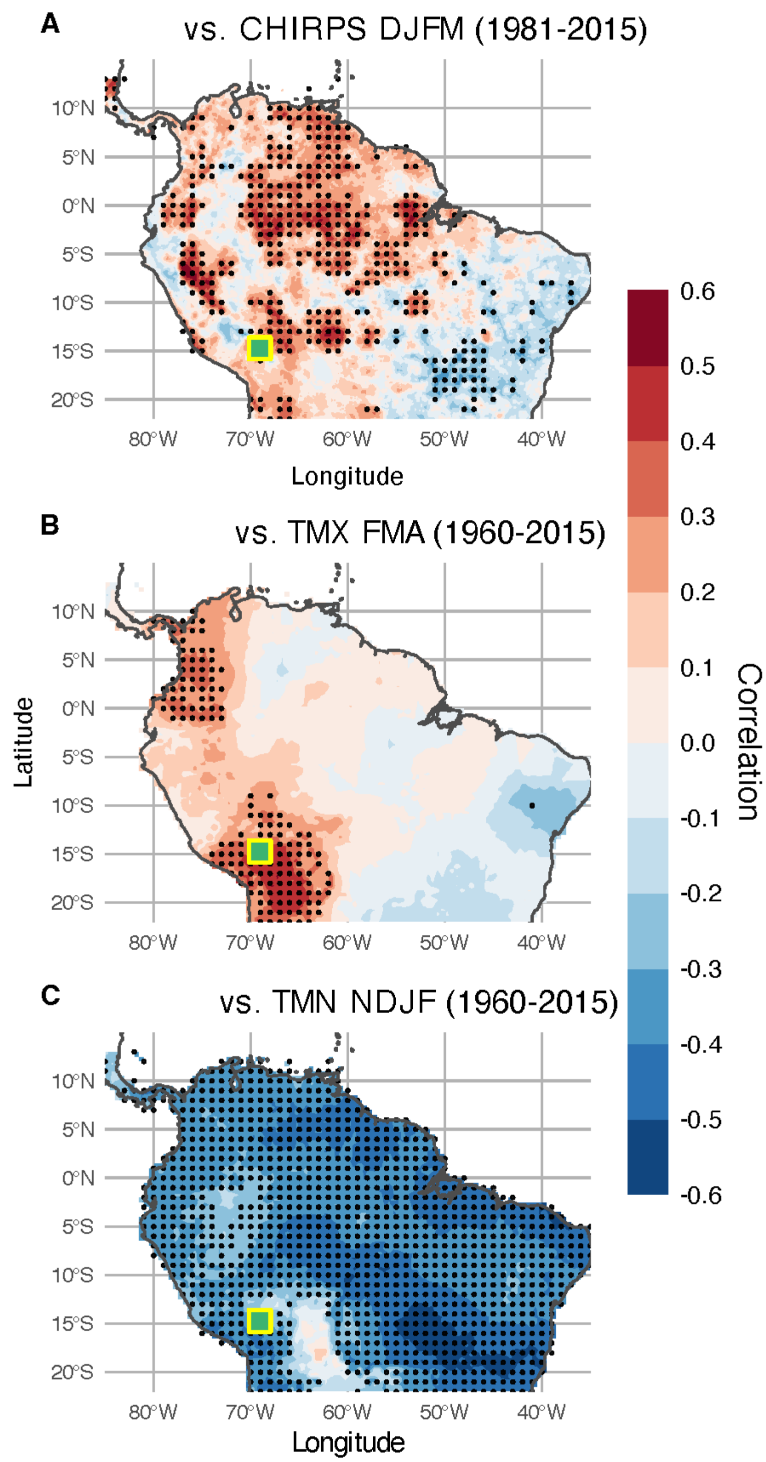


Figure 4. Spatial correlations between P. pepei RW and (A) CHIRPS DJFM precipitation (1981-2015, lag=1), (B) CRU NDJF Tmin (1960-2015, lag=1), and (C) CRU FMA Tmax (1960-2015, lag=0). Black dots represent the areas where there are significant correlations (p<0.05). Binomial field tests indicated there were more significant cells than expected by chance (p=0.05) for all variables (field test p<0.001).

1. Post-revision response to reviewers: egusphere-2025-2032 *Oelkers et al.*

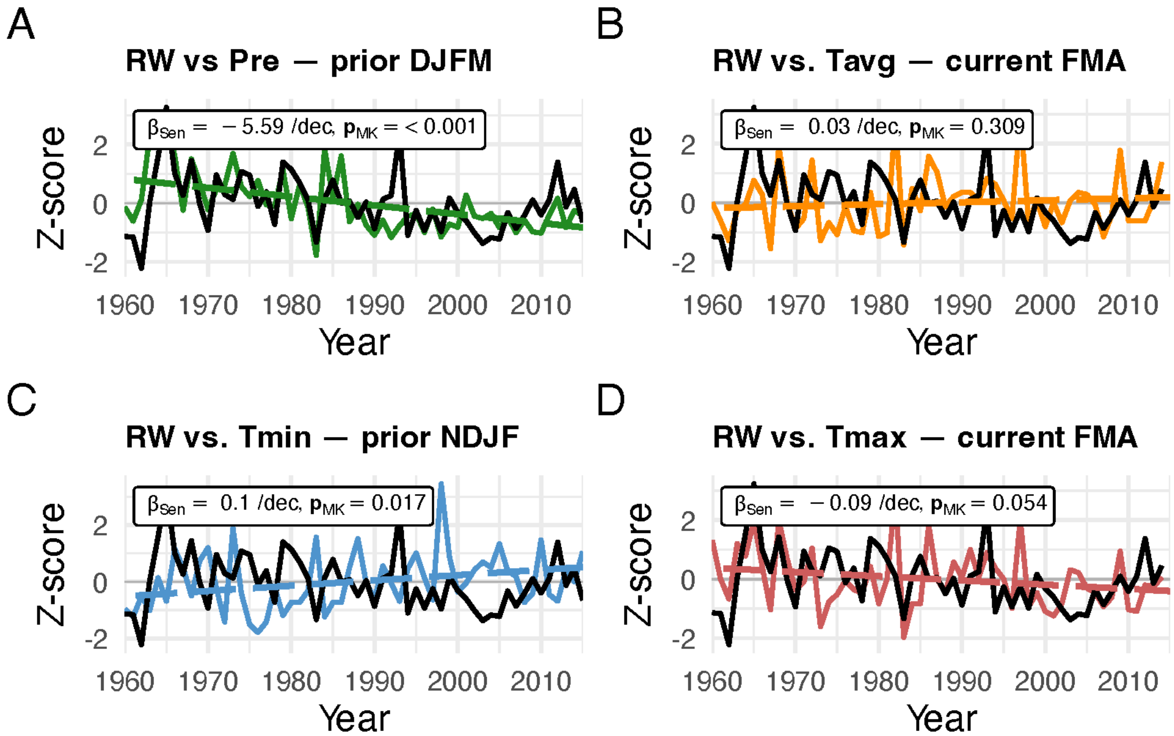
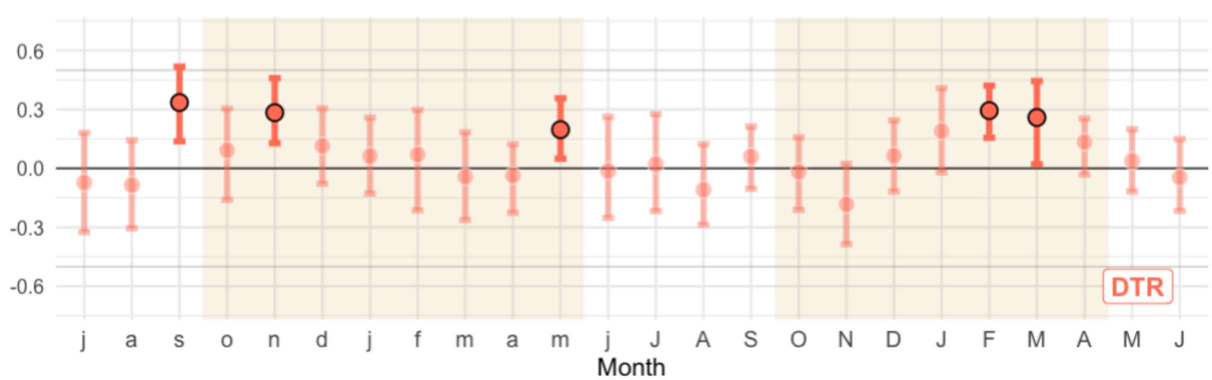


Figure A4. Z-scored P. pepei RW (black lines) and seasonal climate (solid color lines) for seasons with significant bootstrapped correlations between 1960-2105 Pre (A, green) is from reconstructed station data, and Tavg (B, orange), Tmin (C, blue) and (D, red) Tmax from the nearest CRU TS 4.08 gridpoint. Raw climate trends (Sen's slope, beta) are reported in units of climate per decade. Mann-Kendall tests of the slope were used for significance (p_{mk}) estimates.

RW vs. DTR Monthly correlations 1960-2015 Not included in manuscript



1. Post-revision response to reviewers: egusphere-2025-2032 *Oelkers et al.*

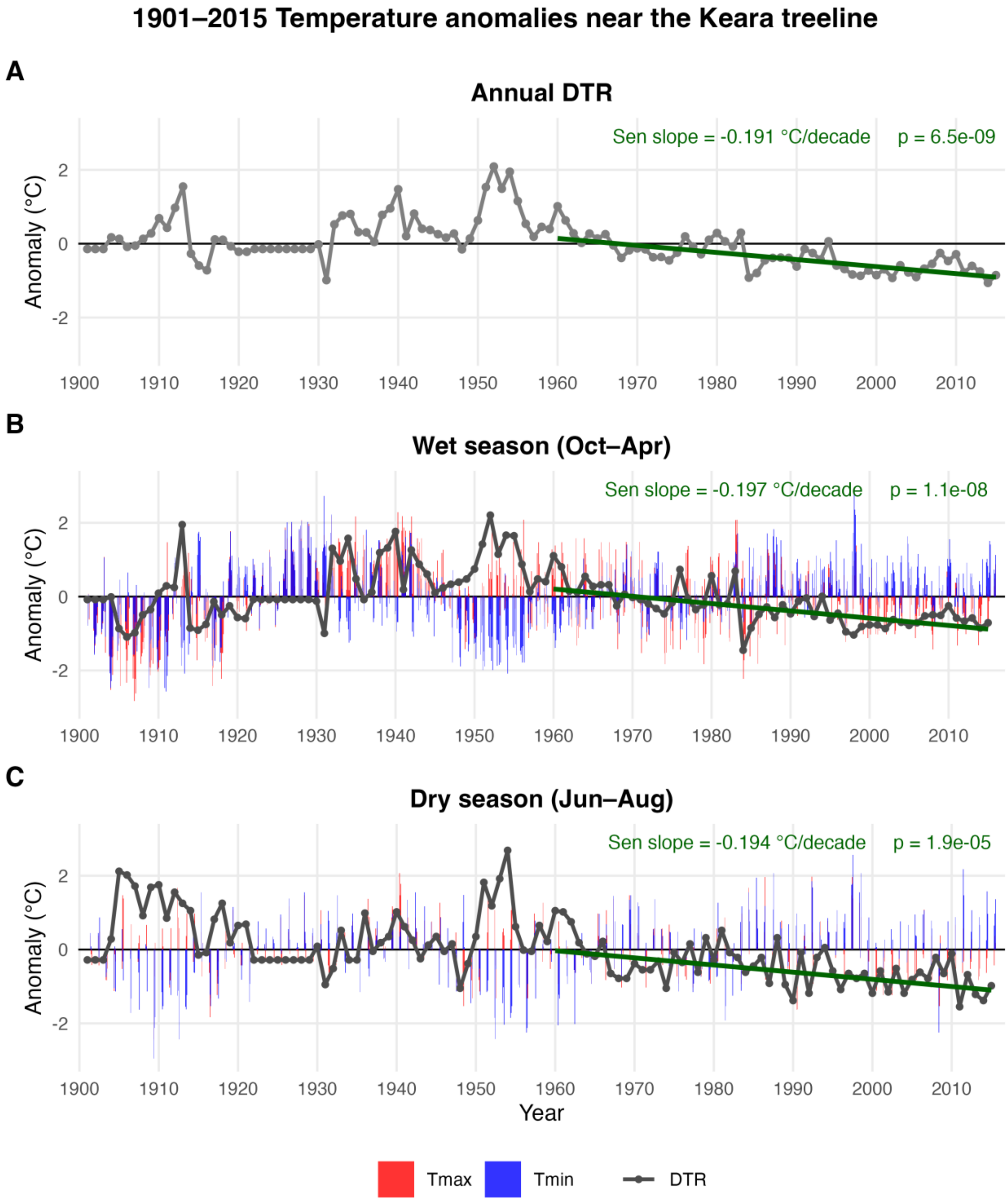


Figure A5. Annual and seasonal temperature anomalies for DTR (grey line; A-C) and monthly anomalies for Tmax (red) and Tmin (blue) for the 1901-2015 period (B-C). 1901 is the earliest year of available data for CRU. Linear trends in DTR anomalies (1960-2015) and their significance were assessed using the Sen's slope estimator and Mann-Kendall test. Slopes are reported as the average change in temperature per decade (°C).

33. Include a map of the species' spatial distribution to help interpret climate response patterns.

> **Although the purpose of this paper was to assess the climate response of the mean chronology (the entire network of** *P. pepe*i), **We have updated figure 1 to include an aerial map of the sites and included the raw radial RW data in Figure 2A. It was super interesting to find that, regardless of site, all trees reflected a recent decline in raw RW and that there was a common growth signal in Keara overall (r=0.50; 1850-2018).**

Discussion

34. Lines 405–407: Be specific about whether growth differences exist between the south- and west-facing slopes. State the number of samples from each slope and how these differences may influence results.

> **This was an extremely useful suggestion. We have generated an aerial map now included in figure 1 and plotted the raw chronologies for the open and closed canopy forests. This helped us to see there weren't major growth differences between sampling locations despite varying microsite conditions.**