Supplementary Information

Contents

Appendix S1. Methods for reconstruction of DBH

For each core, DBH can be reconstructed outside-in (based on recent DBH, subtracting growth recorded in tree rings) or inside-out (summing Δr from the inside out). We generally gave precedence to the outside-in approach. Specifically, when DBH was taken at the time of coring,
At some of our sites where DBH was not taken at the time of coring (*SCBI*,), DBH measurements taken before or slightly after the time of coring could be used. (see issue #19 in ForestGEO_dendro) If before, … If after… For all outside-in reconstructions, if a negative DBH was predicted…

When there were more than one cores for a tree, the DBH reconstructions from each core were averaged to produce a single estimate of the tree's DBH through time. When the start or end dates of the records from the cores differed, we extrapolated growth of the shorter core to match the years covered by the longer core. Specifically, to fill in years at the more recent end, we assumed that the average growth rate of the ten years prior to the missing records applied to the missing years. To fill in years at the beginning of the tree's lifespan, we likewise assumed that the ten years adjacent to the missing record applied to the missing years; however, if this yielded a negative DBH estimate for the earliest year in the reconstruction, we divided the existing minimum DBH by number of years missing and applied that value to each year. We note that these reconstructed growth records were used only for the reconstruction of DBH and were not included as response variables in any of our analyses.

In either case we need bark thickness–ideally allometries describing the relationship between DBH and bark thickness. This is especially critical for thick-barked species When bark thickness data were available, we generated allometries … lognormal model with intercept forced to zero: lm(bark_depth.mm ~ -1 + log(dbh_no_bark.cm+1):bark_species, data = bark) (issue #8 in ForestGEO_dendro)

Appendix S2. Methods for comparing climwin results with traditional methods

(**ISSUE #35 in ForestGEO-climate-sensitivity

Appendix S3. Dealing with rapidly changing climate and tree growth

ISSUE #25 in ForestGEO-climate-sensitivity

Our analysis included two sites where climate change has had pronounced effects on tree growth: Scotty Creek, NW Territories, Canada (SC) and Little Tesuque, New Mexico, USA (LT). At SC, [temperatures have increased by X ° over X years]…, resulting in negative growth trends in basal area index (BAI) starting around 1950 and significant growth declines since 1970 in 56% of trees [@sniderhan_growth_2016].

Tables S1. Site Details

site code	site name	latitude	longitude	cores within ForestGEO plot?	date range	dormant season	months in climwin
SC	Scotty Creek	61.30000	-121.3000	n	NA	NA	pMay-cAug
Zofin	Zofin Forest Dynamics Plot	48.66380	14.7073	y	NA	NA	pMay-cAug
NB	Niobrara/Hansley	42.78000	-100.0210		NA	NA	pMay-cAug
Harvard	Harvard Forest	42.53880	-72.1755	y	NA	NA	pMay-cAug
LDW	Lilly Dickey Woods	39.23590	-86.2181		NA	NA	pMay-cAug
SCBI	Smithsonian Conservation Biology Institute	38.89350	-78.1454	y	NA	NA	pMay-cAug
Utah	Utah Forest Dynamics Plot	37.66150	-112.8525		NA	NA	pMay-cAug
LT	Little Tesuque	35.73838	-105.8382	NA	NA	NA	pMay-cAug
HKK	Huai Kha Khaeng	15.63240	99.2170	n	NA	NA	pOct-cDec
BCI	Barro Colorado Island	9.15430	-79.8461	n	NA	NA	pOct-cDec

Tables S2. List of species analyzed

Site	Code	Species	leaf type	n trees	n cores	bark
SCBI	LITU	Liriodendron tulipifera	BD	NA	NA	NA

Table S3. allometric equations for bark thickness

Figure S1. Comparison of our approach with traditional methods of identifying climate signals

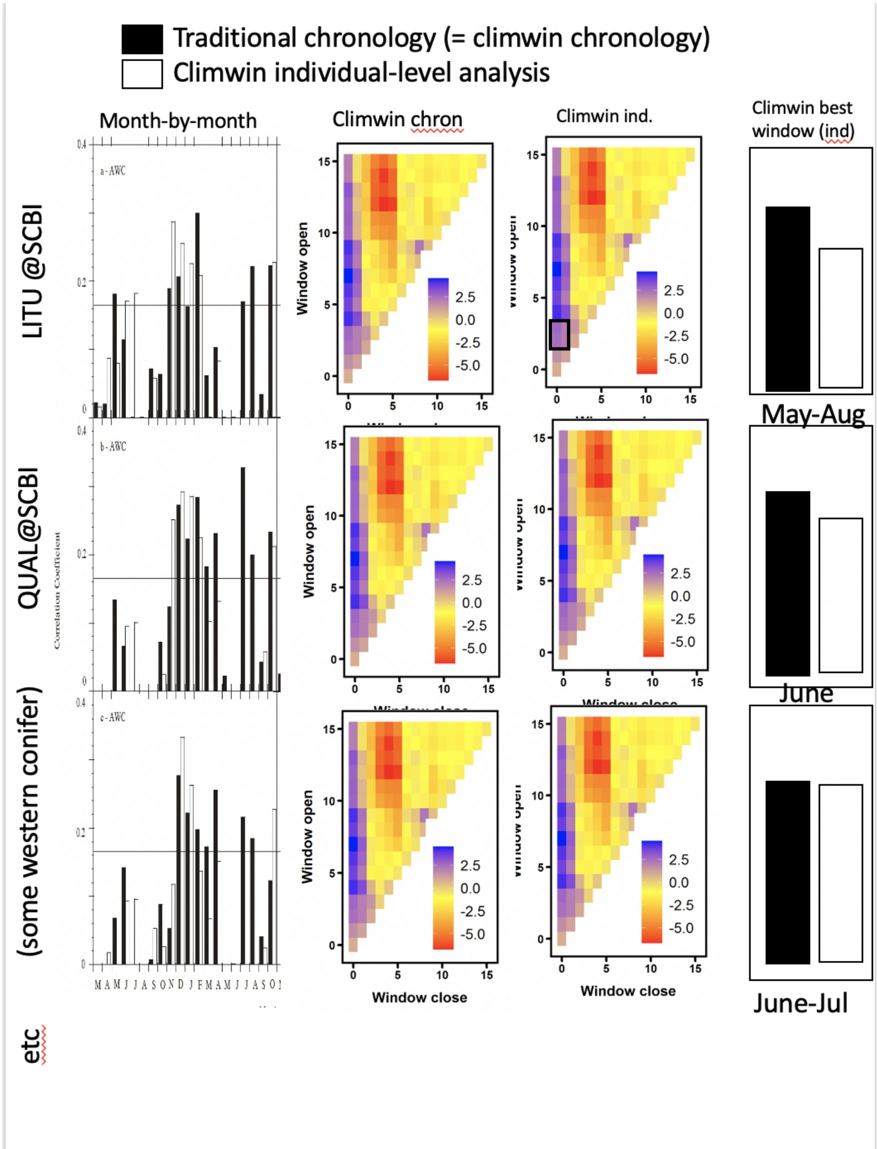

Figure S1 | (Comparison of traditional approaches with ours). (THIS FIGURE IS JUST A MOCK-UP TO SHOW VALENTINE WHAT I HAVE IN MIND.)

Figure S2. Comparison of climwin output across growth metrics for the temperature variable group at Little Tesuque (New Mexico, USA)

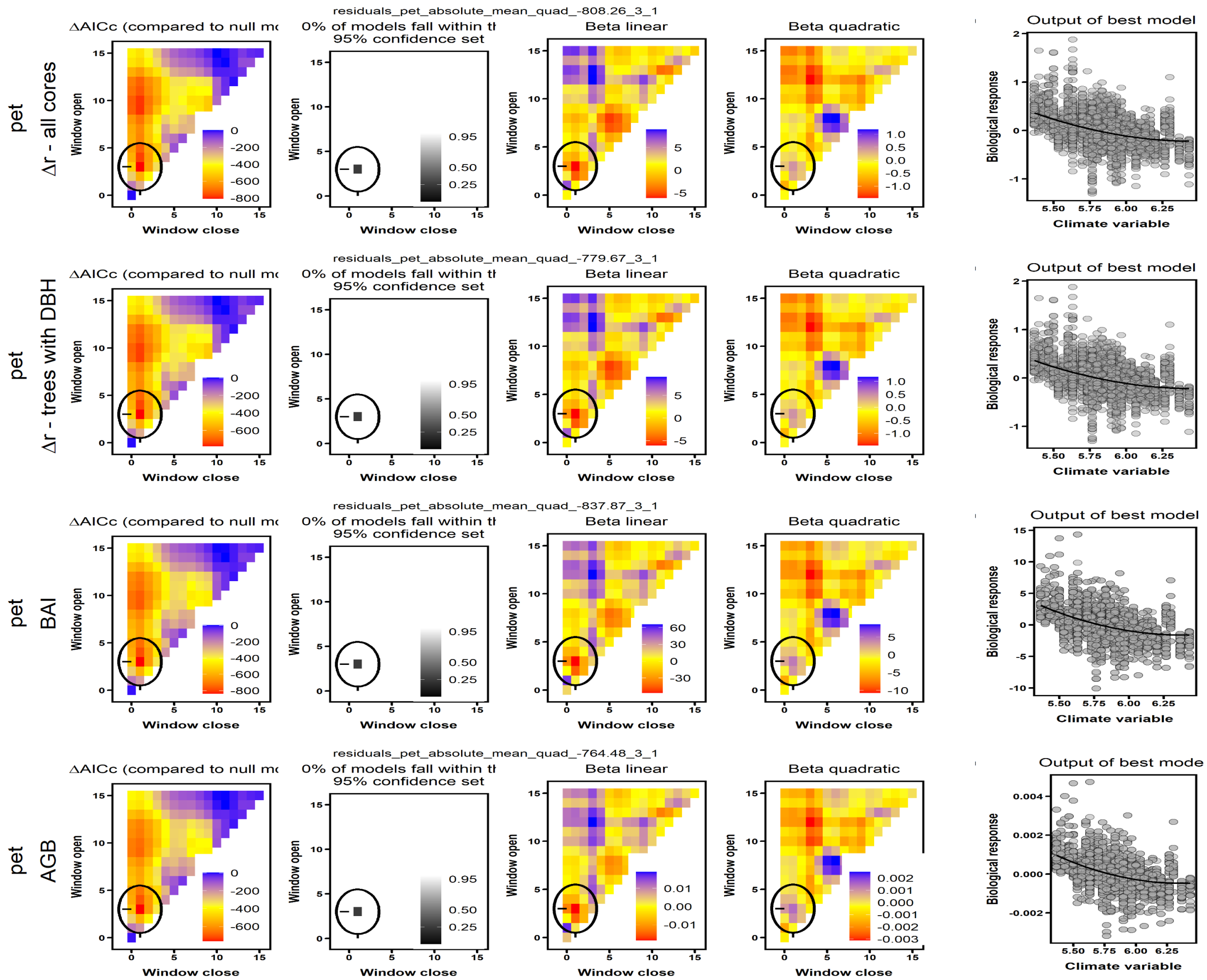

Figure S2 | Comparison of climwin output across growth metrics for the temperature variable group at Little Tesuque (New Mexico, USA). Here, *climwin* identified potential evapotranspiration (PET) as the strongest climate variable across all three metrics of growth (Δr, BAI, ΔAGB) and regardless of whether all cores were included in the analysis, or only those for which DBH could be reconstructed (Δr-trees with DBH, BAI, ΔAGB).)

Figure S3. Comparison of climwin output across growth metrics for the precipitation variable group at Little Tesuque (New Mexico, USA)

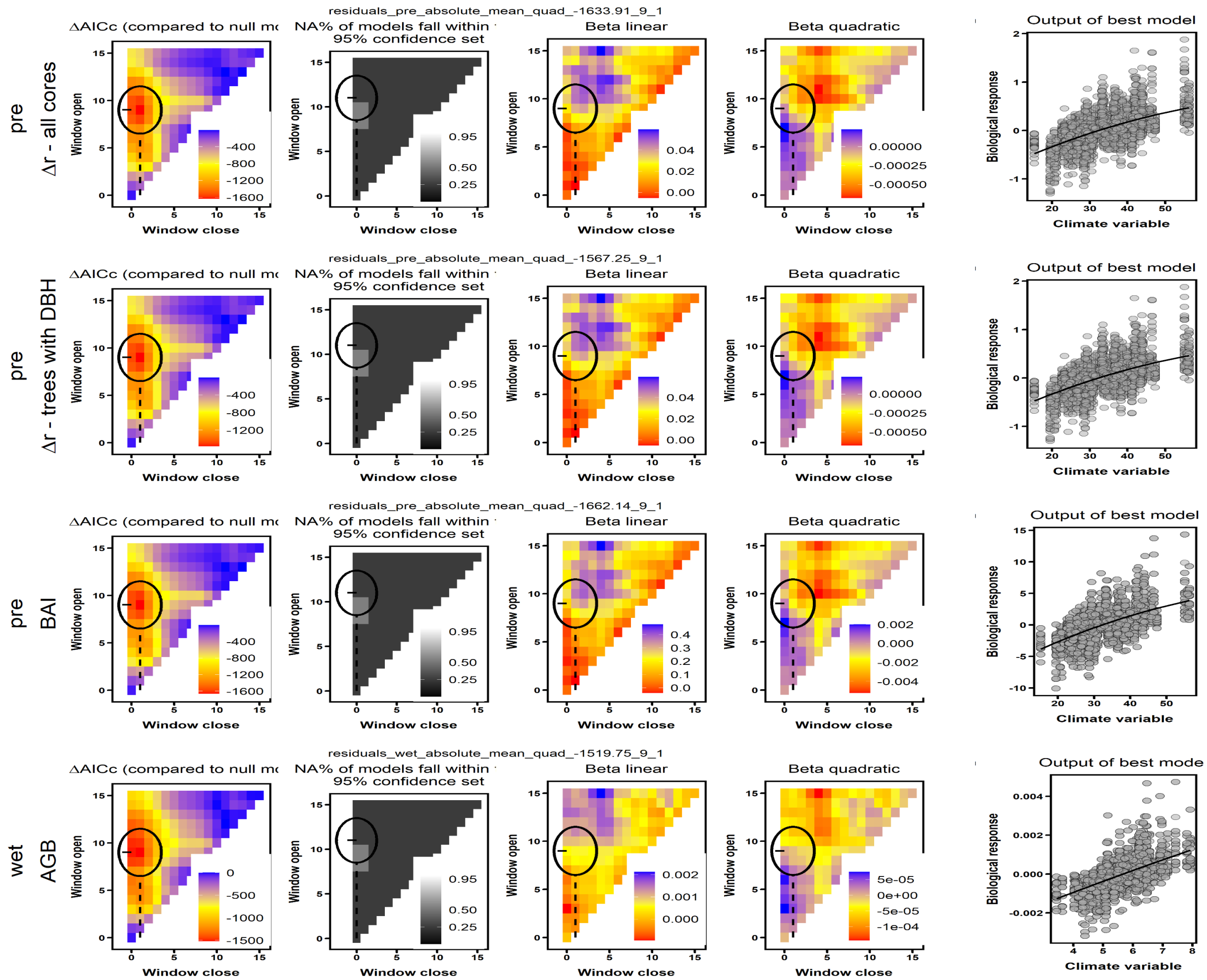

Figure S3 | Comparison of climwin output across growth metrics for the precipitation variable group at Little Tesuque (New Mexico, USA). Here, *climwin* identified precipitation (PRE) as the strongest climate variable for Δr and BAI, but precipitation day frequency (WET) as the strongest climate variable for ΔAGB.

Figure S4. Comparison of climwin output across growth metrics for the precipitation variable group at Harvard Forest (Massachusetts, USA)

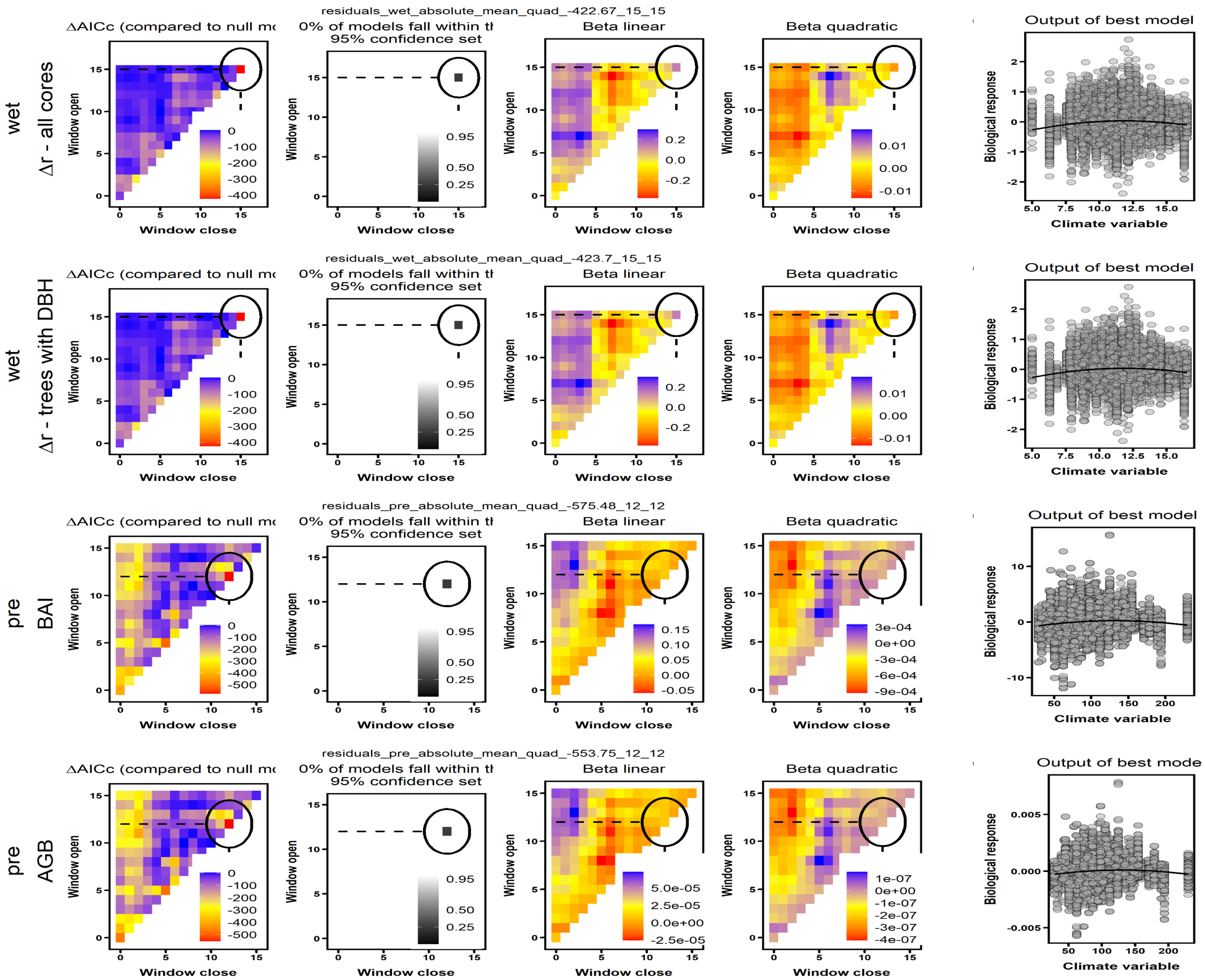

Figure S4 | Comparison of climwin output across growth metrics for the precipitation variable group at Harvard Forest (Massachusetts, USA). Here, *climwin* identified precipitation frequency (WET) as the strongest climate variable for Δr, but precipitation amount (PRE) as the strongest climate variable for BAI and ΔAGB. The optimal time window (circled) also differed across growth metrics.

Figure S5. Best GLS models for Barro Colorado Island (Panama)

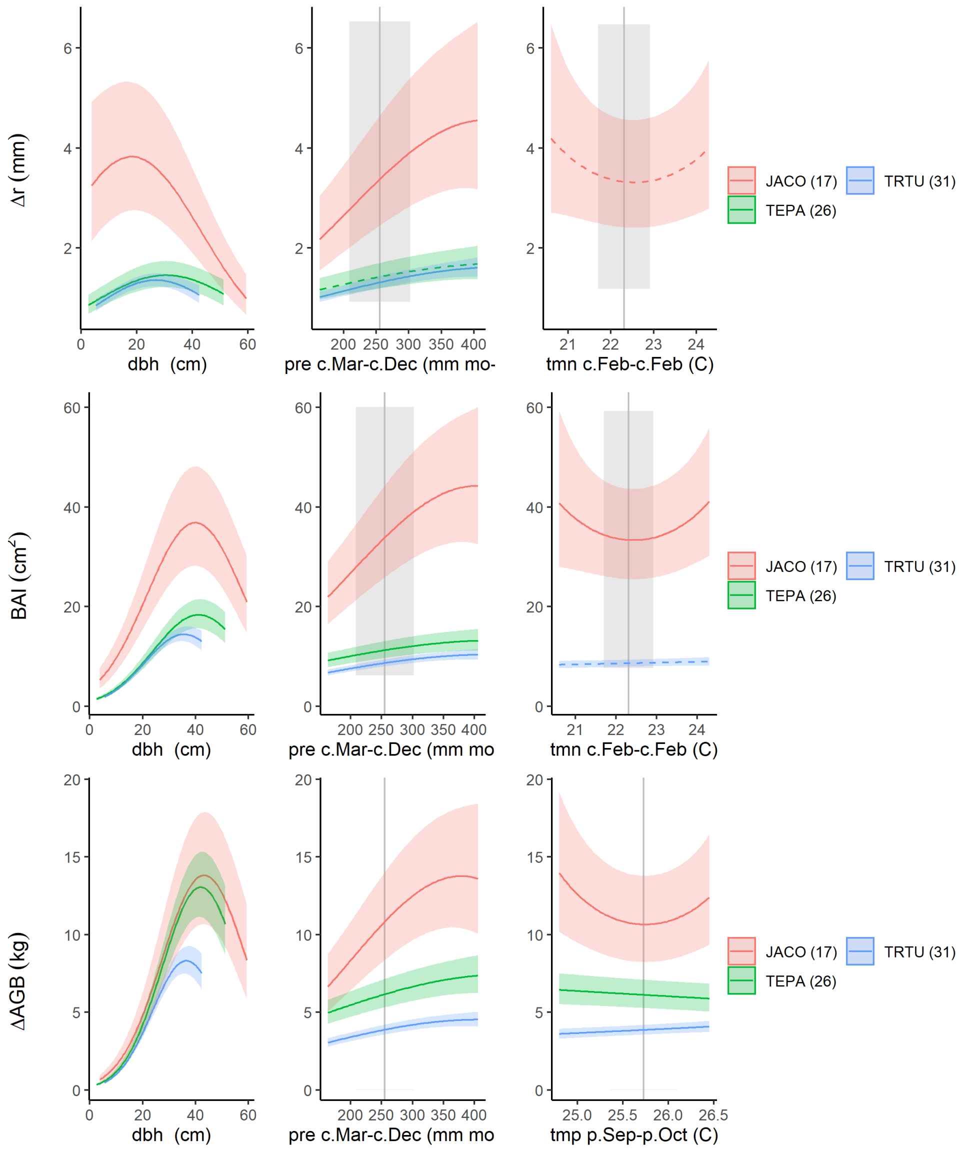

Figure S5 | Best GLS models for Barro Colorado Island (Panama) for all three growth metrics: Δr, BAI, and ΔAGB. Precipitation and temperature group variables are as selected by *climwin*. For each species, relationships are plotted if included in top model, with dashed lines indicating terms that do not significantly improve the model (relative to a model without). Vertical grey lines indicate the long-term mean for the climate variable, shading indicates 1 SD.

Figure S6. Best GLS models for Huai Kha Khaeng (Thailand)

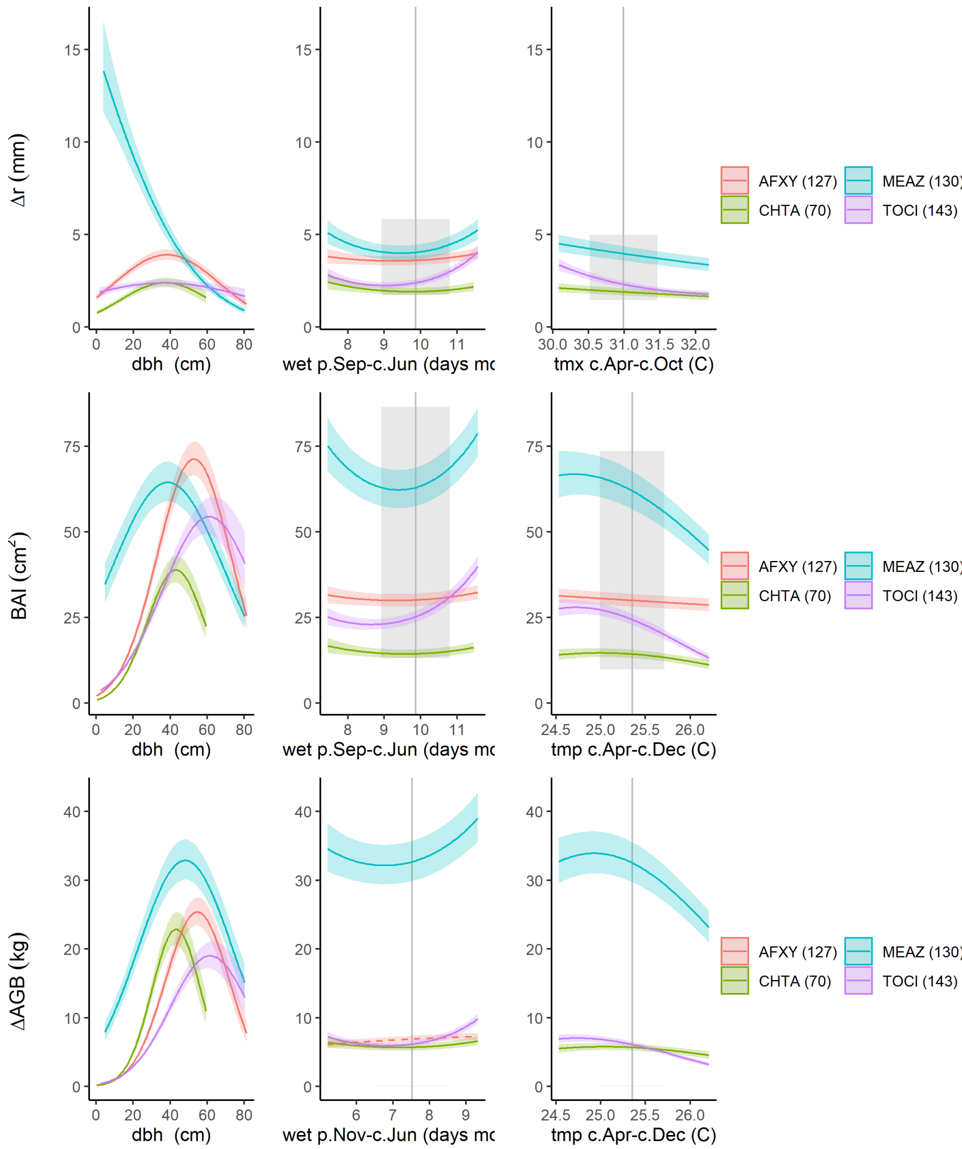

Figure S6 | Best GLS models for Huai Kha Khaeng (Thailand) for all three growth metrics: Δr, BAI, and ΔAGB. Precipitation and temperature group variables are as selected by *climwin*. For each species, relationships are plotted if included in top model, with dashed lines indicating terms that do not significantly improve the model (relative to a model without). Vertical grey lines indicate the long-term mean for the climate variable, shading indicates 1 SD.

Figure S7. Best GLS models for Little Tesuque (New Mexico, USA)

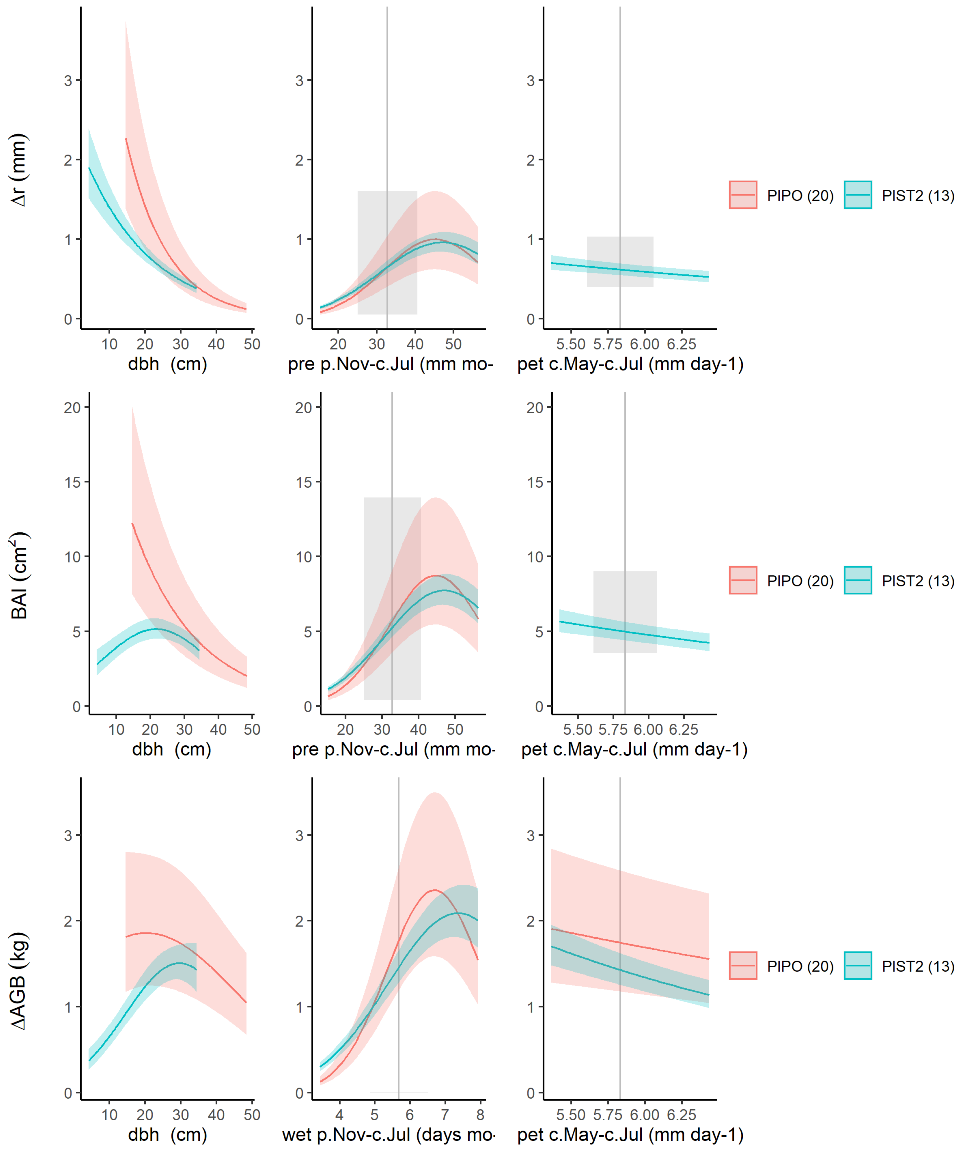

Figure S7 | Best GLS models for Little Tesuque (New Mexico, USA) for all three growth metrics: Δr, BAI, and ΔAGB. Precipitation and temperature group variables are as selected by *climwin*. For each species, relationships are plotted if included in top model, with dashed lines indicating terms that do not significantly improve the model (relative to a model without). Vertical grey lines indicate the long-term mean for the climate variable, shading indicates 1 SD.

Figure S8. Best GLS models for Cedar Breaks (Utah, USA)

[**Figure S8 | Best GLS models for Cedar Breaks (Utah, USA) for all three growth metrics: Δr, BAI, and ΔAGB.** Precipitation and temperature group variables are as selected by *climwin.* For each species, relationships are plotted if included in top model, with dashed lines indicating terms that do not significantly improve the model (relative to a model without). Vertical grey lines indicate the long-term mean for the climate variable, shading indicates 1 SD.]

Figure S9. Best GLS models for SCBI (Virginia, USA)

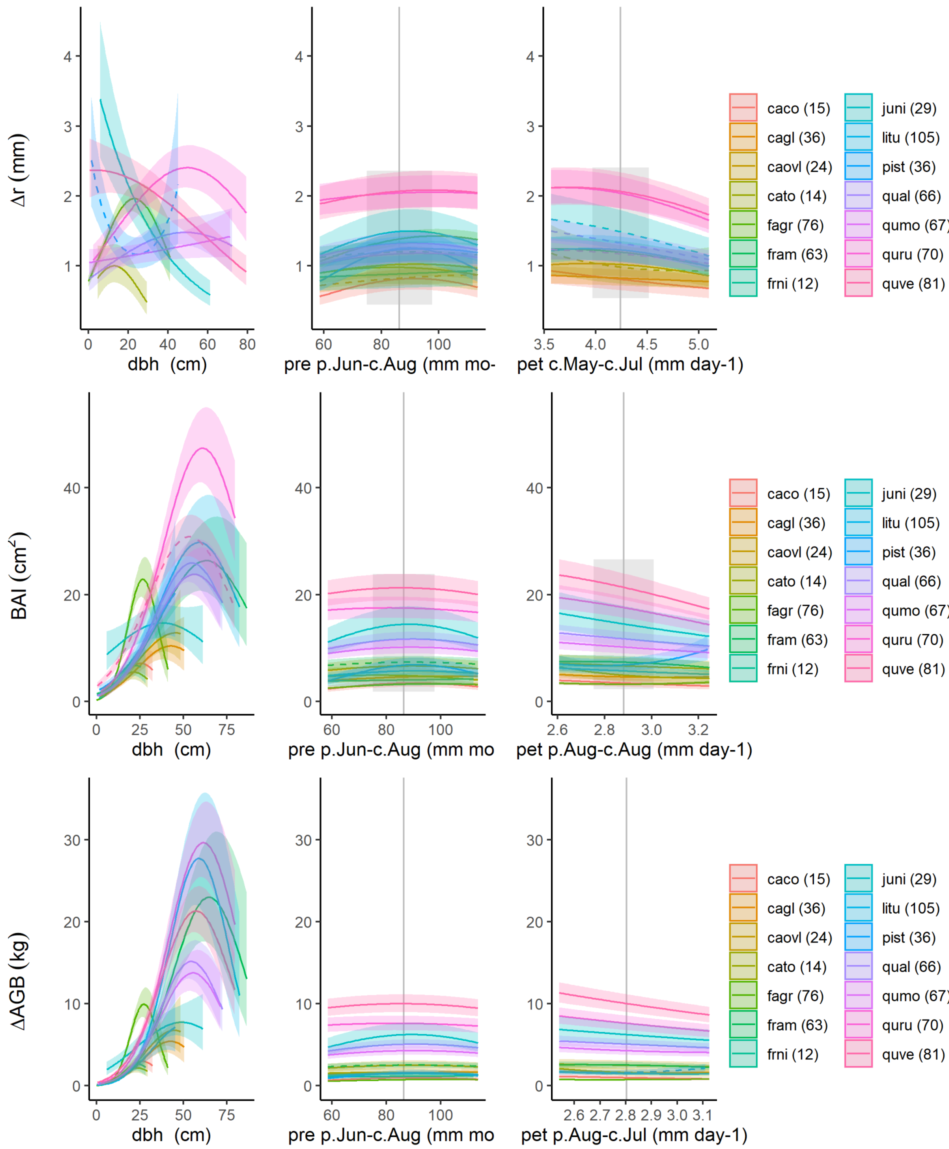

Figure S9 | Best GLS models for SCBI (Virginia, USA) for all three growth metrics: Δr, BAI, and ΔAGB. Precipitation and temperature group variables are as selected by *climwin*. For each species, relationships are plotted if included in top model, with dashed lines indicating terms that do not significantly improve the model (relative to a model without). Vertical grey lines indicate the long-term mean for the climate variable, shading indicates 1 SD.

Figure S10. Best GLS models for Lilly Dickey Woods (Indiana, USA)

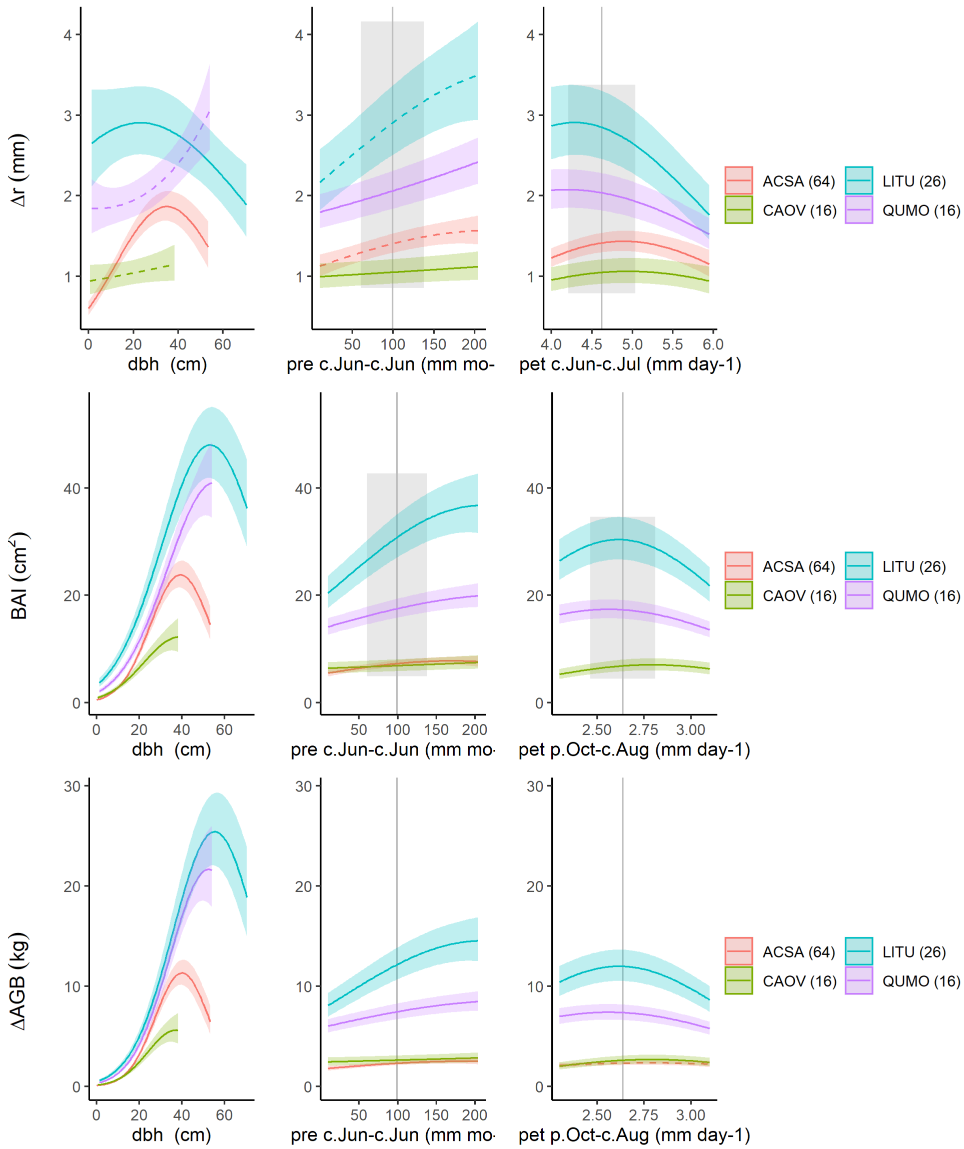

Figure S10 | Best GLS models for Lilly Dickey Woods (Indiana, USA) for all three growth metrics: Δr, BAI, and ΔAGB. Precipitation and temperature group variables are as selected by *climwin*. For each species, relationships are plotted if included in top model, with dashed lines indicating terms that do not significantly improve the model (relative to a model without). Vertical grey lines indicate the long-term mean for the climate variable, shading indicates 1 SD.

Figure S11. Best GLS models for Harvard Forest (Massachusetts, USA)

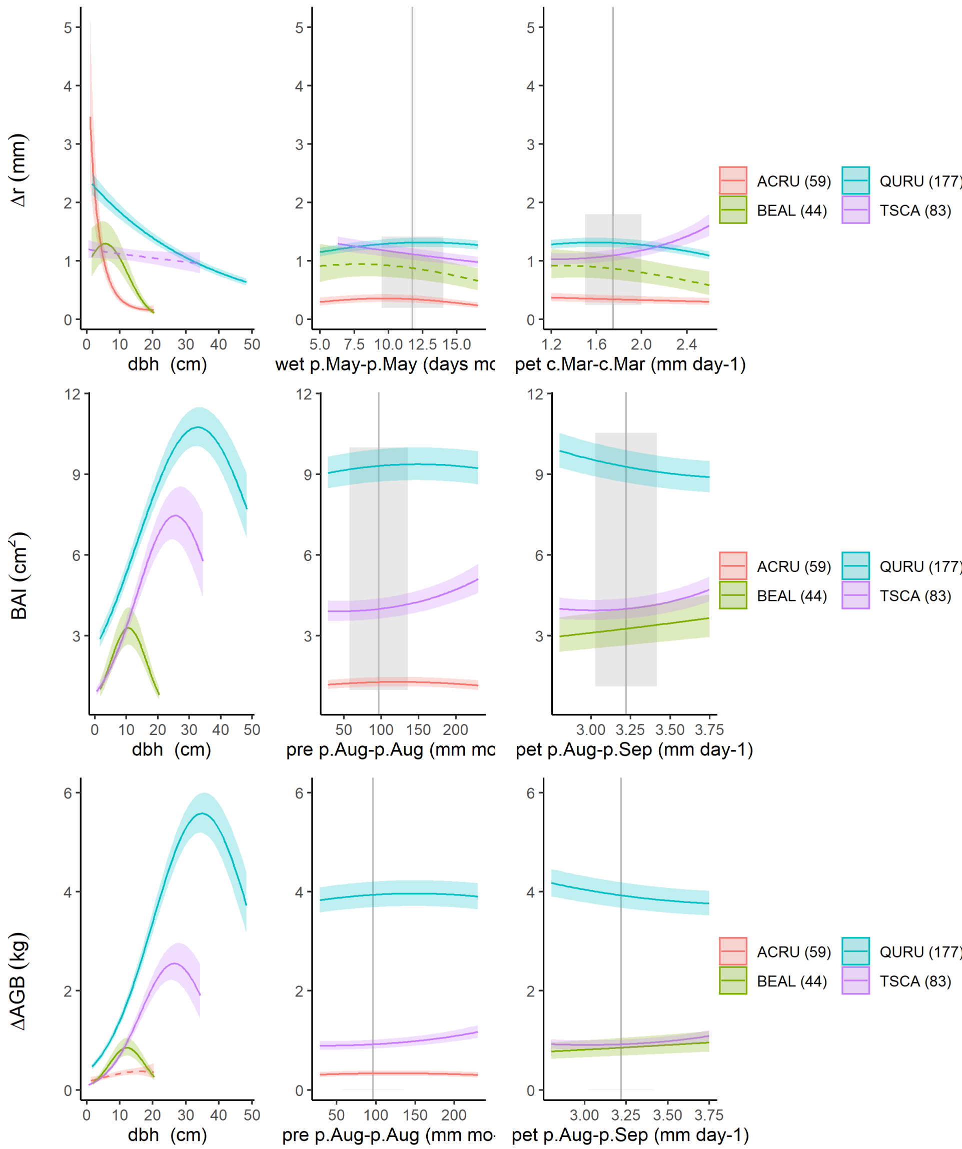

Figure S11 | Best GLS models for Harvard Forest (Massachusetts, USA) for all three growth metrics: Δr, BAI, and ΔAGB. Precipitation and temperature group variables are as selected by *climwin*. For each species, relationships are plotted if included in top model, with dashed lines indicating terms that do not significantly improve the model (relative to a model without). Vertical grey lines indicate the long-term mean for the climate variable, shading indicates 1 SD.

Figure S12. Best GLS models for Niobrara/ Hansley (Nebraska, USA)

Figure S13. Best GLS models for Zofin (Czech Republic)

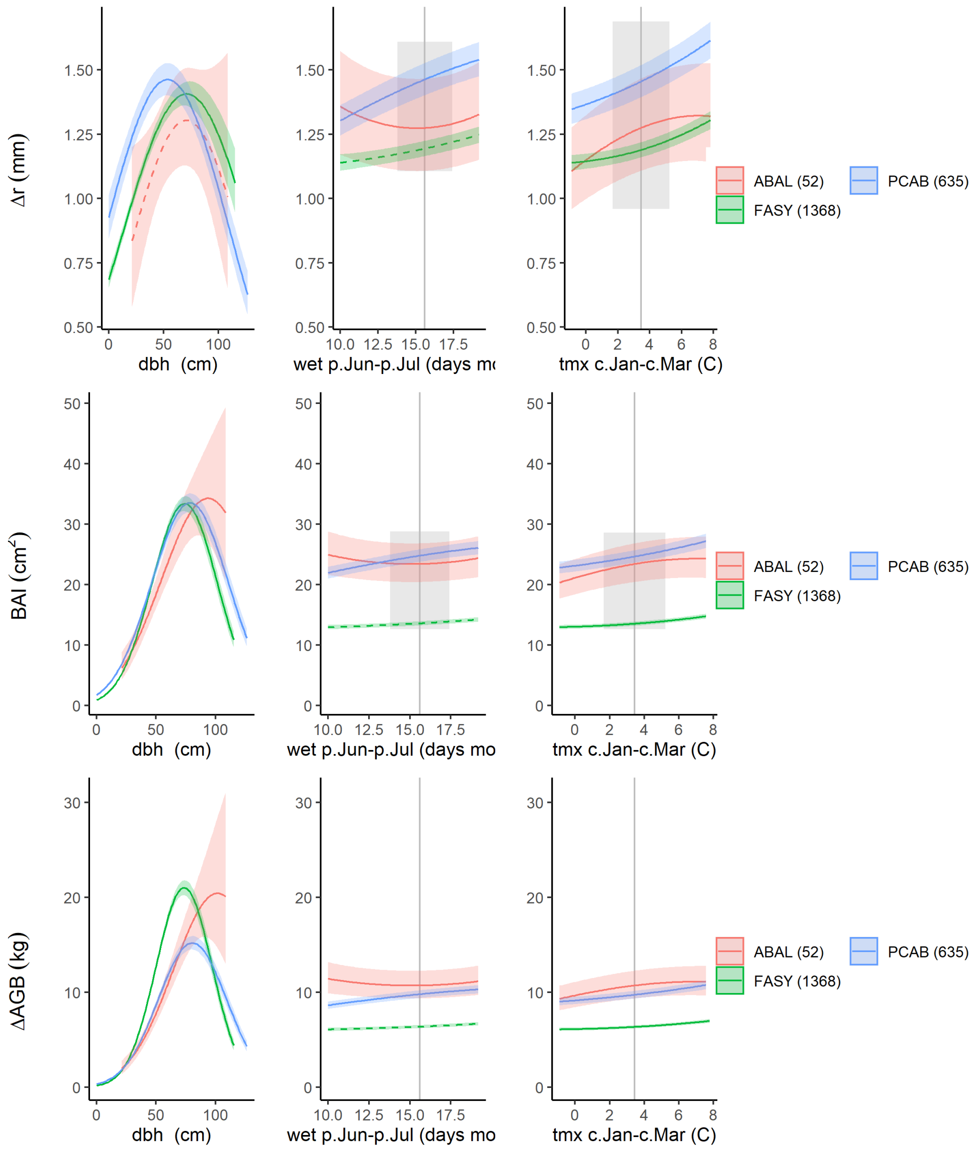

Figure S13 | Best GLS models for Zofin (Czech Republic) for all three growth metrics: Δr, BAI, and ΔAGB. Precipitation and temperature group variables are as selected by *climwin*. For each species, relationships are plotted if included in top model, with dashed lines indicating terms that do not significantly improve the model (relative to a model without). Vertical grey lines indicate the long-term mean for the climate variable, shading indicates 1 SD.

Figure S14. Best GLS models for Scotty Creek (NW Territories, Canada)

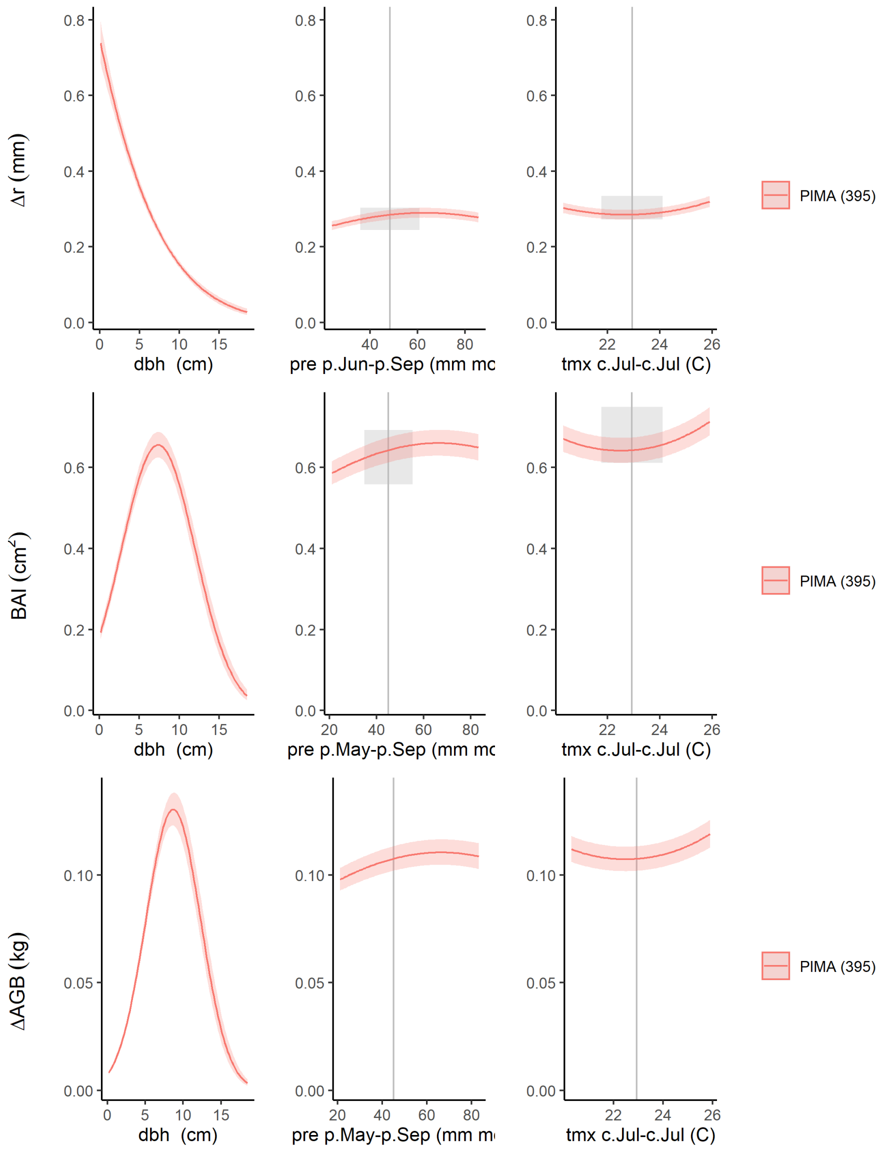

Figure S14 | Best GLS models for Scotty Creek (NW Territories, Canada) for all three growth metrics: Δr, BAI, and ΔAGB. Precipitation and temperature group variables are as selected by *climwin*. For each species, relationships are plotted if included in top model, with dashed lines indicating terms that do not significantly improve the model (relative to a model without). Vertical grey lines indicate the long-term mean for the climate variable, shading indicates 1 SD.