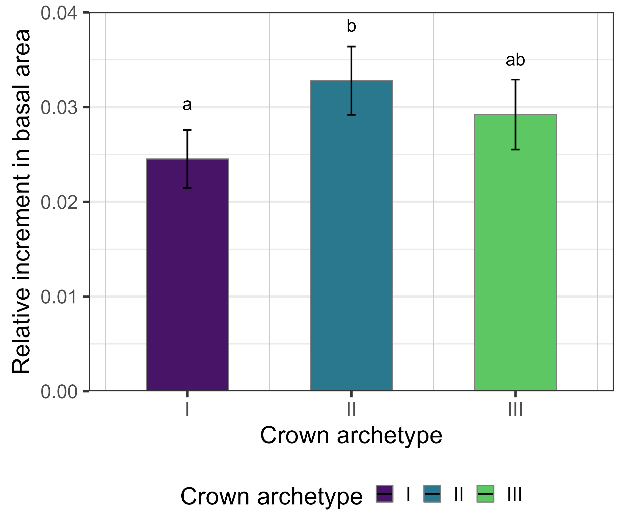
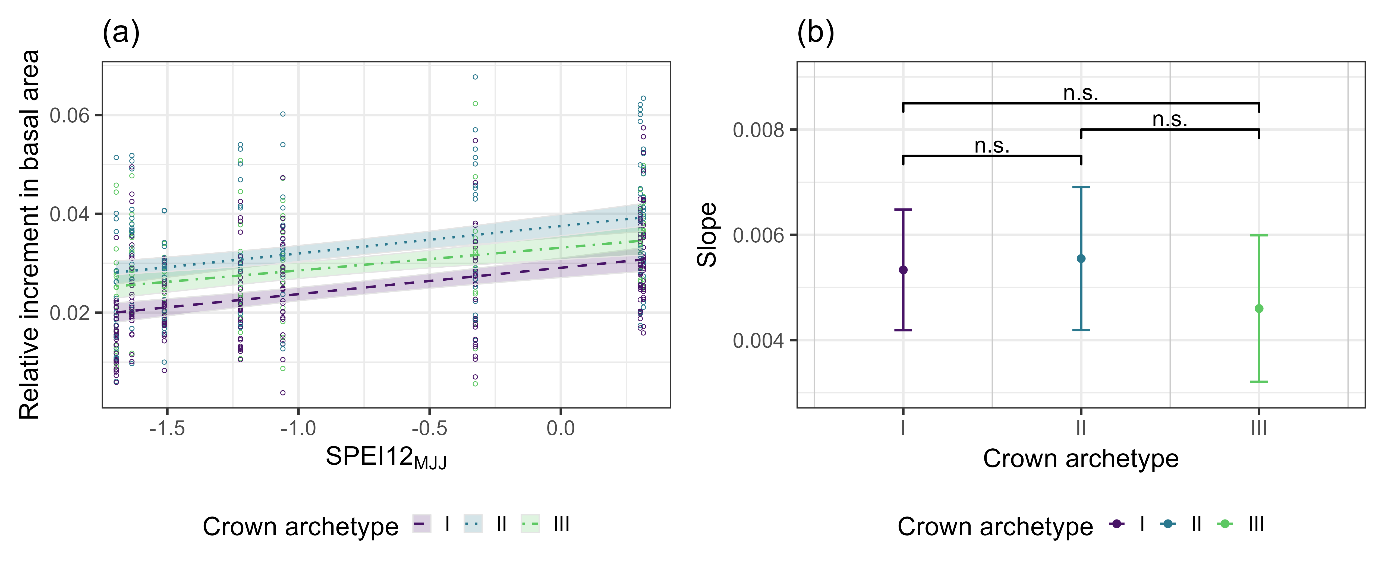
# Supplementary material

**Table S1** Overview of the computed crown variables, their units and short descriptions.

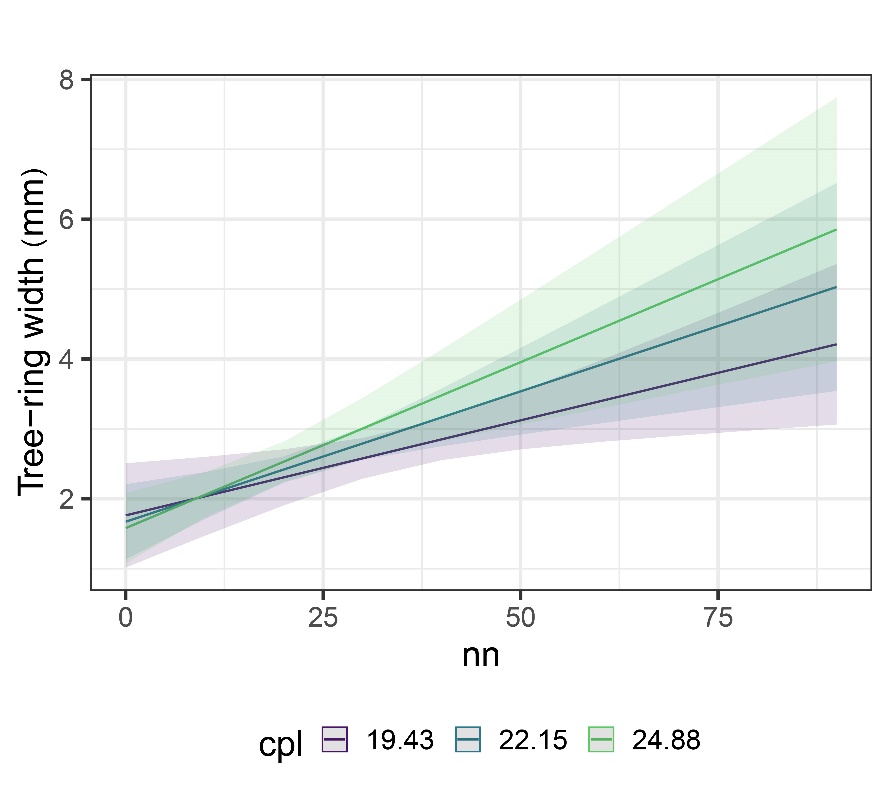
|  |  |  |
| --- | --- | --- |
| **Variable** | **Unit** | **Description** |
| **Whole tree** | |  |
| *h* | m | Tree height |
| dbh | m | Diameter at breast height |
| **Crown morphology** | |  |
| cbh | m | Crown base height |
| cl | m | Crown length |
| cw | m | Crown width (maximum crown diameter) |
| cfr | - | Crown fullness ratio (ratio between crown width and crown length) |
| csl | - | Crown spreading level (ratio between crown width and tree height) |
| cor | - | Crown outreach ratio (ratio between crown width and diameter at breast height) |
| cth | - | Crown top-heaviness (calculated after Pretzsch et al., 2022) |
| sdcr | m | Standard deviation of mean crown radius in 20 height classes |
| cpa | m2 | Crown projection area (projection area of the crown alpha shape) |
| bvol | m3 | Branch volume (volume of all QSM branch cylinders) |
| cv | m3 | Crown volume (volume of the crown alpha shape) |
| cca | m2 | Crown coat area (surface area of the crown alpha shape) |
| suc | - | Proportion of light crown (ratio of light crown length and total crown length, light crown length calculated dependent on height of maximum crown radius) |
| cas | - | Crown asymmetry (calculated after Shi et al., 2018) |
| **Branch architecture** | |  |
| nb | - | Number of all branches |
| nb1 | - | Number of primary branches |
| maxbo | - | Maximum branching order |
| bmd | - | Branch mass density of crown volume (ratio between crown volume and branch volume) |
| *n* | - | Number of branching nodes (bifurcations) |
| cpl | m | Average water conduction path length from all branch tips to soil |
| nn | - | Average number of branching nodes per conduction path |
| dia\_branch | m | Average branch base diameter |
| len\_branch | m | Average branch length |
| zen\_branch | ° | Average branch zenith angle |



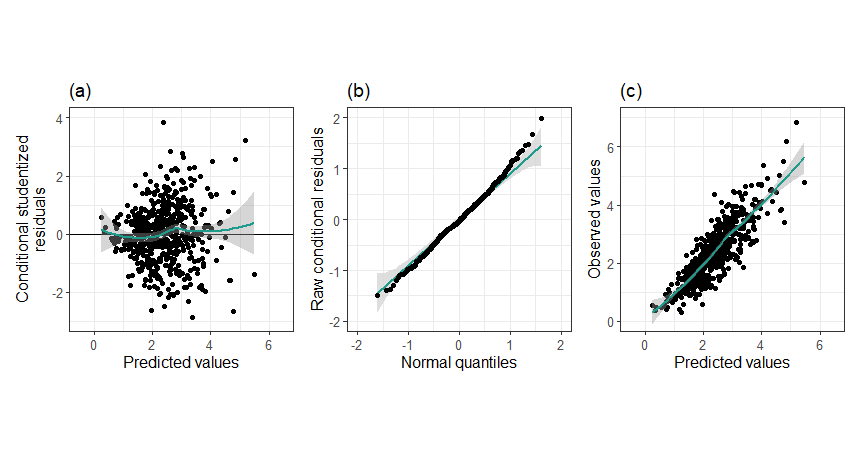
**Fig. S1** Estimated marginal means of relative increment in basal area for the crown archetypes. The bars indicate the 95% confidence intervals. Different letters indicate a significant difference based on an alpha-level of 5%.



**Fig. S2** **(a)** Measured and estimated relative increment in basal area against the SPEI12MJJ values between 2015 and 2022 by crown archetype. The shaded areas represent 95% confidence intervals. **(b)** Modelled slope values per crown archetype with bars indicating the 95% confidence intervals and brackets indicating whether the difference between them is significant (s) or not (n.s.).



**Fig. S3** Effect plot for the complex model estimating tree-ring width based on the dbh, environmental impacts as well as the branch architectural variables cpl and nn. The relationship between nn and the response is presented for different levels of cpl. The shaded areas represent 95% confidence intervals.



**Fig. S4** Diagnostic plots for the complex model, estimating tree-ring widths based on the dbh, environmental impacts as well as branch architectural variables cpl and nn. **(a)** Conditional studentized residuals against predicted values. **(b)** Raw conditional residuals against normal quantiles. **(c)** Observed values against predicted values.

**Table S2** Output of the complex model estimating relative increment in basal area based on environmental impacts as well as branch architectural variables cpl and nn. All continuous predictors were scaled prior to modelling. Fructification and frost were entered as dummy variables, where the intercept represents absence of the respective event.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Predictor** | **Estimate** | **Confidence Interval (95%)** | | ***p*-value (ANOVA)** |
| (Intercept) | 0.0311 | 0.0290 – 0.0333 | | **<0.001** |
| SPEI12MJJ | 0.0045 | 0.0038 – 0.0051 | | **<0.001** |
| Fructification | ‒0.0014 | ‒0.0027 ‒ ‒0.0002 | | **0.030** |
| Frost | ‒0.0043 | ‒0.0057 ‒ ‒0.0028 | | **<0.001** |
| SPEI12MJJ × Fructification | ‒0.0021 | ‒0.0040 ‒ ‒0.0001 | | **0.038** |
| cpl | ‒0.0003 | ‒0.0030 – 0.0024 | | 0.842 |
| nn | 0.0050 | 0.0020 – 0.0080 | | **0.002** |
| cpl × nn | 0.0017 | 0.0008 – 0.0027 | | **<0.001** |
| Marginal *R*2 | 0.26 | - | - | |
| Conditional *R*2 | 0.68 | - | - | |

**Table S3** P-values of the (Welch-) ANOVA and estimated marginal means analysis for models in Eqs. 2 and 3, testing the significance of predictors and the difference between the archetypes I, II and III, respectively.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Model** | **Response variable** | **(Welch-) ANOVA** | | | **emmeans-analysis** | | |
|  | Archetype | SPEI12MJJ | Archetype × SPEI12MJJ | I - II | I – III | II - III |

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Equation 2 | trw | **< 0.001** | - | - | 0.134 | **< 0.001** | **0.008** |
| riba | **< 0.001** | **-** | **-** | **0.002** | 0.131 | 0.354 |
| Equation 3 | trw | **< 0.001** | **< 0.001** | 0.662 | 0.898 | 0.851 | 0.636 |
| riba | **0.004** | **<0.001** | 0.599 | 0.969 | 0.703 | 0.603 |

# References

Pretzsch, H., Ahmed, S., Jacobs, M., Schmied, G., Hilmers, T., 2022. Linking crown structure with tree ring pattern: methodological considerations and proof of concept. Trees. 36(4), 1349–1367. https://doi.org/10.1007/s00468-022-02297-x

Shi, P., Zheng, X., Ratkowsky, D.A., Li, Y., Wang, P., Cheng, L., 2018. A simple method for measuring the bilateral symmetry of leaves. Symmetry 10(4), 4. https://doi.org/10.3390/sym10040118