

Supplemental materials

Intra-Annual Radial Growth of *Pinus kesiya* var. *langbianensis* Is Mainly Controlled by Moisture Availability in the Ailao Mountains, Southwestern China

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Table S1. Characterization of the seasonal growth patterns of *Pinus kesiya* var. *langbianensis* during the study period, predicted by the Gompertz model fitting on daily means of stem radius variations (SRV). Means and standard deviations (in brackets) were calculated from three individuals.

| Variables | 2012 | 2013 | 2014 | 2015 | 2017 |
|--------------------------------------|--------------|-------------|--------------|--------------|--------------|
| Time of growth initiation (DOY) | 85(11.0) | 112(9.5) | 121(3.2) | 101(19.5) | 93(28.1) |
| Time of growth cessation (DOY) | 289(14.2) | 286(11.8) | 281(22.3) | 282(10.7) | 290(19.1) |
| Growth season duration (days) | 203(25.0) | 174(2.3) | 160(25.1) | 181(19.5) | 196(44.4) |
| Day of Maximum growth (DOY) | 145(7.8) | 160(14.0) | 173(7.4) | 160(18.1) | 166(4.0) |
| Maximum growth rate (mm/day) | 0.022(0.005) | 0.031(0.01) | 0.024(0.007) | 0.027(0.014) | 0.031(0.009) |
| Cumulative annual radial growth (mm) | 4.3(1.39) | 5.0(1.84) | 3.6(1.38) | 4.5(1.83) | 6.0(2.3) |

Table S2. Model selections of linear mixed-effects models fitted on daily sums of growth-induced irreversible stem expansion (GRO rate) and daily minimum tree water deficit (TWD). Mixed-effects models were performed separately for GRO rate and TWD, with climate variables as fixed factors and individual trees nested in years and a first-order auto-correlation structure as random factor. T_{\max} : maximum temperature; PRE: precipitation; RH: relative humidity; WS: wind speed; PAR: photosynthetic active radiation; vapor pressure deficit (VPD).

| Dependent | Model fixed effects | AIC | BIC | AIC |
|-----------|-----------------------------------|---------|---------|-----|
| GRO rate | PRE + RH | 3285.93 | 3322.23 | 0 |
| | T_{\max} + PRE + RH | 3290.78 | 3332.26 | 4.9 |
| | T_{\max} + WS + PRE + RH | 3294.33 | 3340.98 | 3.6 |
| | T_{\max} + WS + PAR + PRE + RH | 3300.61 | 3352.44 | 6.3 |
| TWD | WS + PRE + VPD | 1968.59 | 2004.48 | 0 |
| | T_{\max} + WS + PRE + VPD | 1967.06 | 2007.42 | 1.5 |
| | T_{\max} + WS + PAR + PRE + VPD | 1971.47 | 2016.30 | 4.4 |

Table S3. Summary of linear mixed-effects models on daily sums of growth-induced irreversible stem expansion (GRO rate). Mixed-effects models were performed for each year, with climate variables as fixed factors, and individual trees and a first-order auto-correlation structure as random factor. The values of GRO rate and precipitation were log-transformed. All dependent and predict variables were scaled to their mean. T_{mean} : mean air temperature; PRE: precipitation; RH: relative humidity; PAR: photosynthetic active radiation.

| Year | Variable | Estimate | SE | df | t-Value | p-Value |
|------|------------|----------|-------|---------|---------|------------------|
| 2012 | T_{\max} | -0.111 | 0.113 | 242.000 | -0.984 | 0.326 |
| | PAR | -0.064 | 0.132 | 242.000 | -0.487 | 0.626 |
| | PRE | 0.211 | 0.061 | 242.000 | 3.450 | 0.001 |
| | RH | 0.293 | 0.220 | 242.000 | 1.331 | 0.184 |
| 2013 | T_{\max} | 0.013 | 0.111 | 216.000 | 0.114 | 0.910 |
| | PAR | 0.034 | 0.071 | 216.000 | 0.476 | 0.634 |
| | PRE | 0.291 | 0.079 | 216.000 | 3.703 | <0.001 |
| | RH | 0.246 | 0.112 | 216.000 | 2.202 | 0.029 |
| 2014 | T_{\max} | -0.109 | 0.067 | 270.000 | -1.634 | 0.103 |
| | PAR | 0.013 | 0.076 | 270.000 | 0.174 | 0.862 |
| | PRE | 0.295 | 0.040 | 270.000 | 7.305 | <0.001 |
| | RH | 0.198 | 0.192 | 270.000 | 1.030 | 0.304 |
| 2015 | T_{\max} | 0.086 | 0.073 | 273.000 | 1.171 | 0.243 |
| | PAR | -0.026 | 0.106 | 273.000 | -0.248 | 0.804 |
| | PRE | 0.224 | 0.051 | 273.000 | 4.373 | <0.001 |
| | RH | 0.632 | 0.223 | 273.000 | 2.831 | 0.005 |
| 2017 | T_{\max} | -0.026 | 0.090 | 288.000 | -0.287 | 0.774 |
| | PAR | -0.062 | 0.231 | 288.000 | -0.271 | 0.787 |
| | PRE | 0.245 | 0.068 | 288.000 | 3.581 | <0.001 |
| | RH | 0.980 | 0.340 | 288.000 | 2.884 | 0.004 |

Table S4. Summary of linear mixed-effects models on daily minimum of tree water deficit (TWD). Mixed-effects models were performed for each year, with climate variables as fixed factors and individual trees as random factor. The values of TWD and precipitation were log-transformed. All dependent and predict variables were scaled to their mean. T_{max}: maximum air temperature; PAR: photosynthetic active radiation; PRE: precipitation; VPD: vapor pressure deficit.

| Year | Variable | Estimate | SE | df | t-Value | p-Value |
|------|------------------|----------|-------|---------|---------|------------------|
| 2012 | T _{max} | -0.147 | 0.172 | 143.000 | -0.856 | 0.393 |
| | PAR | -0.122 | 0.207 | 143.000 | -0.589 | 0.557 |
| | PRE | -0.082 | 0.090 | 143.000 | -0.916 | 0.361 |
| | VPD | 0.706 | 0.308 | 143.000 | 2.294 | 0.023 |
| 2013 | T _{max} | 0.190 | 0.144 | 87.000 | 1.321 | 0.190 |
| | PAR | -0.431 | 0.145 | 87.000 | -2.966 | 0.004 |
| | PRE | -0.446 | 0.145 | 87.000 | -3.078 | 0.003 |
| | VPD | 0.039 | 0.242 | 87.000 | 0.163 | 0.871 |
| 2014 | T _{max} | -0.170 | 0.144 | 95.000 | -1.179 | 0.242 |
| | PAR | -0.325 | 0.145 | 95.000 | -2.245 | 0.027 |
| | PRE | -0.074 | 0.114 | 95.000 | -0.647 | 0.519 |
| | VPD | 1.344 | 0.317 | 95.000 | 4.244 | <0.001 |
| 2015 | T _{max} | -0.548 | 0.106 | 150.000 | -5.152 | <0.001 |
| | PAR | -0.274 | 0.178 | 150.000 | -1.537 | 0.127 |
| | PRE | -0.119 | 0.095 | 150.000 | -1.251 | 0.213 |
| | VPD | 1.052 | 0.325 | 150.000 | 3.233 | 0.002 |
| 2017 | T _{max} | -0.279 | 0.174 | 152.000 | -1.608 | 0.110 |
| | PAR | 0.356 | 0.222 | 152.000 | 1.600 | 0.112 |
| | PRE | -0.092 | 0.124 | 152.000 | -0.738 | 0.462 |
| | VPD | 0.062 | 0.383 | 152.000 | 0.161 | 0.873 |

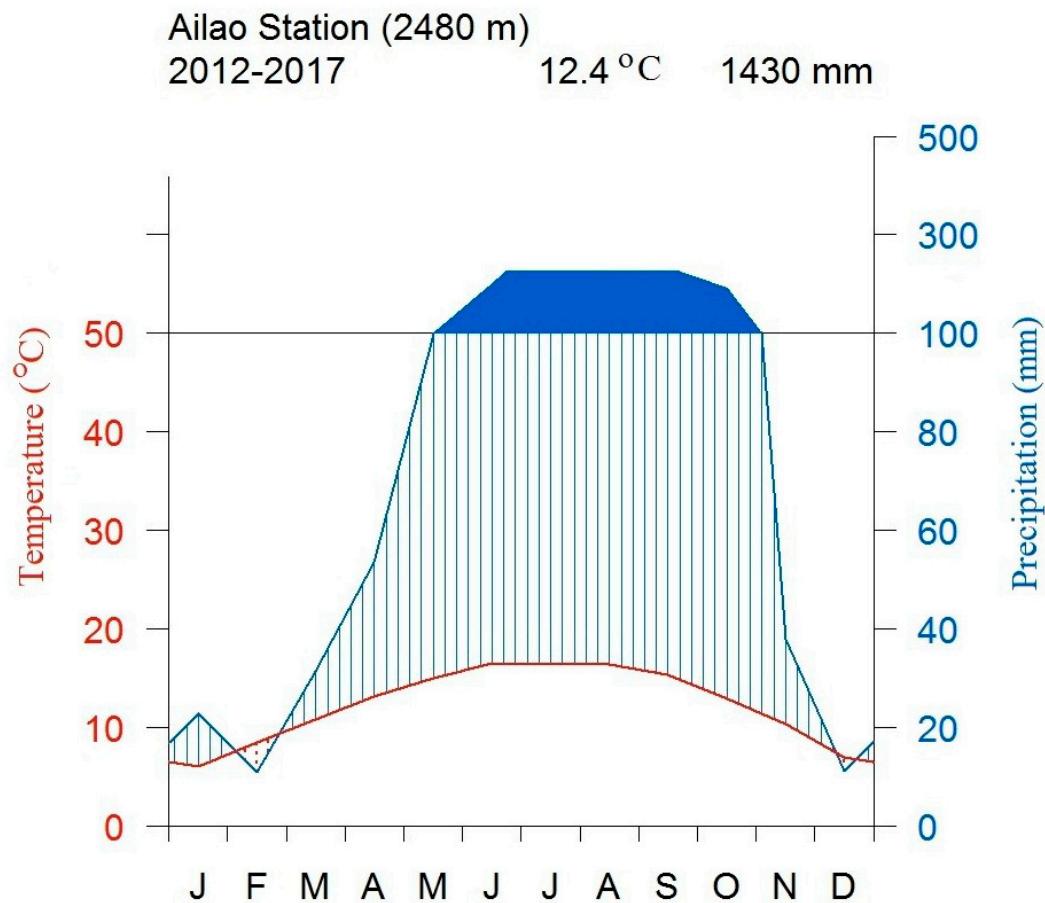


Figure S1. Climate diagram for the Ailao station averaged for the period 2012–2017. Mean annual air temperatures and precipitation are indicated on top of the graph.

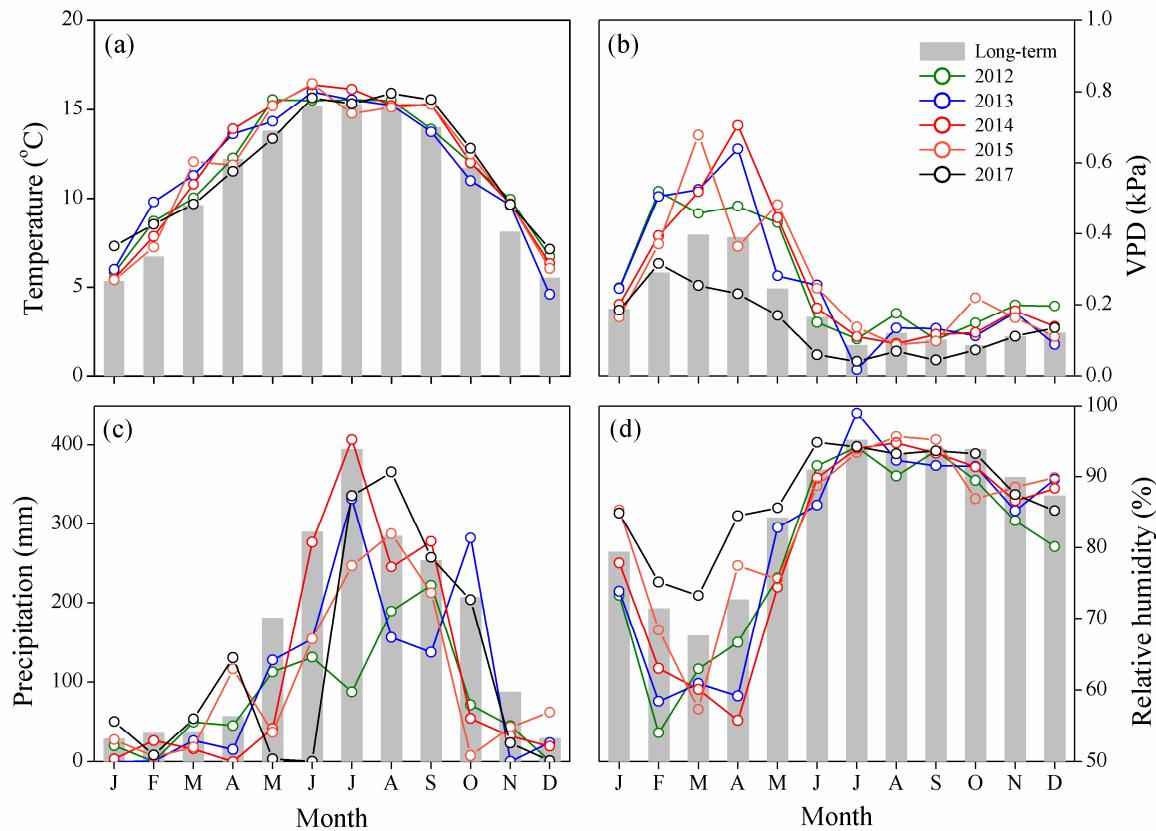


Figure S2. Comparison of the monthly climate conditions during 2012–2015 and 2017 (dot-lines) and long-term means (bars) from 1982 to 2011 for the Ailaoshan meteorological station.

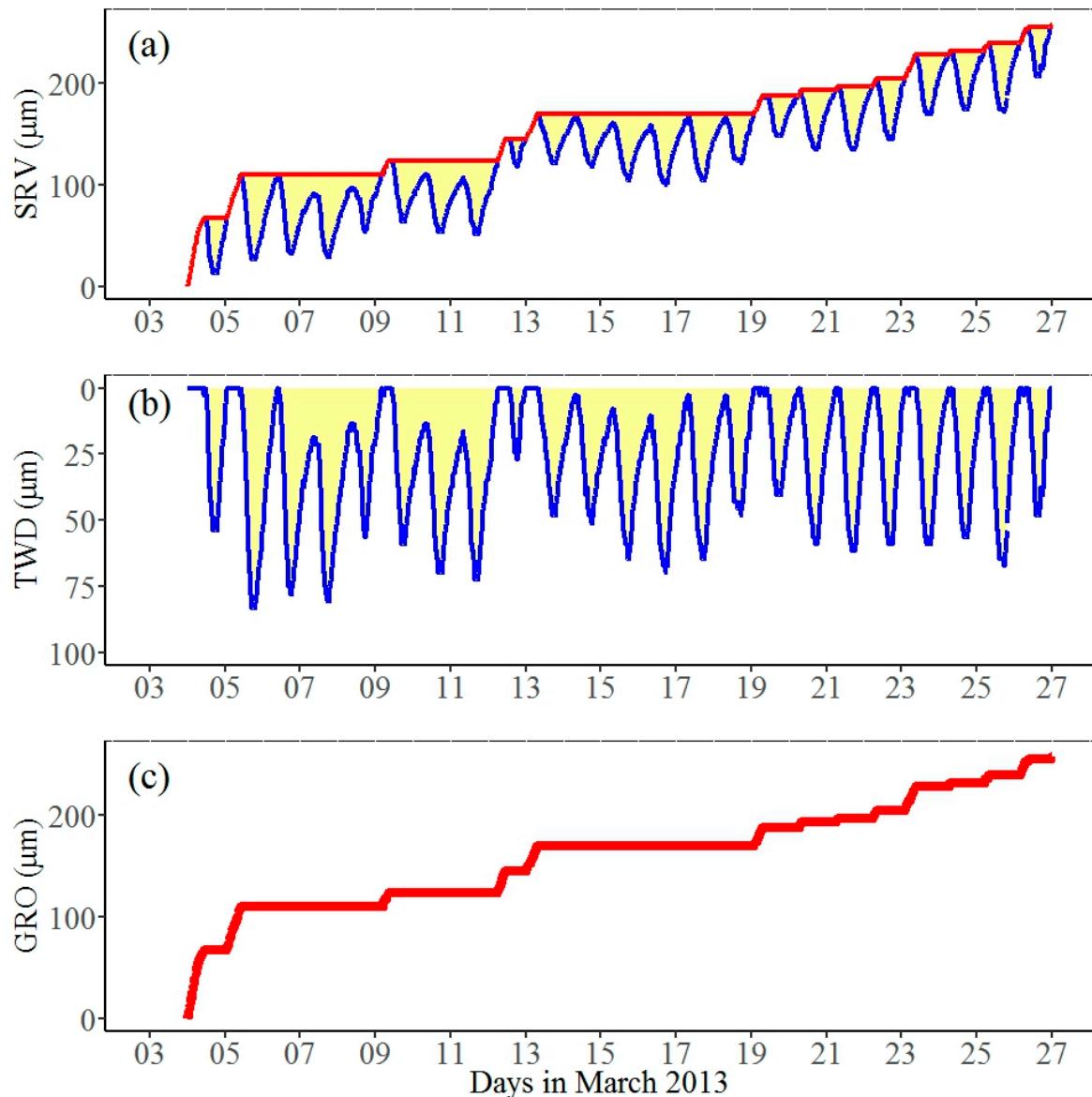


Figure S3. Illustration for separating continuous stem radius (SR) measurements into tree water deficit-induced stem shrinkage (TWD) and growth-induced irreversible expansion (GRO, red line), according to the zero-growth (ZG) model (Zweifel et al. 2016). (a) Stem radius variations (SRV, blue line); (b) tree water deficit (TWD, yellow shade), calculated as the difference between the maximum precedent SR and the actual SR; (c) the sum of growth-induced irreversible stem expansion (GRO, red line) including cell division and cell elongation in the wood and bark.