

1 **Supporting Information**

2 **Appendix S1** Description of the water budget model.

3 The monthly potential evapotranspiration (PET_m) was computed using the Turc equation
4 (Turc, 1961) (see eqn S1).

$$5 \quad PET_m = n \times 0.0133333 \times (Rg_m + 50) \times (t_m / (t_m + 15)) \quad \text{eqn S1}$$

6 with n = number of days of the month, t_m = the monthly temperature and Rg_m = the monthly
7 potential radiation.

8 The water budget computed monthly soil water content (SWC_m) for each plot over the
9 period 1980-2001, with initial condition for January 1980 SWC_m set as SWC_{max} (the
10 maximum soil water content). Then monthly soil water content was iteratively computed
11 using eqn S2.

$$12 \quad SWC_{m+1} = \min(SWC_m + Precip_{s\ m} - AET_m, SWC_{max}) \quad \text{eqn S2}$$

13 With $Precip_{s\ m}$ = the infiltrating precipitation, AET_m = the monthly actual evapotranspiration
14 computed by eqn S3.

$$15 \quad AET_m = \min(D_m, S_m) \quad \text{eqn S3}$$

16 with $D_m = PET_m - Precip_{i\ m}$ where $Precip_{i\ m}$ is the the intercepted precipitation.

17 and $S_m = c_w * SWC_m / SWC_{max}$ where c_w is a parameter denoting the maximum
18 evapotranspiration from a saturated soil under conditions of high demand (as in Bugmann &
19 Cramer 1998 we assume that $c_w = 12$ cm/month).

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21 $Precip_{i\ m}$ and $Precip_{s\ m}$ are computed with eqns S4 and S5

$$22 \quad Precip_{i\ m} = \min(f_i * P_m, PET_m) \quad \text{eqn S4}$$

23 with f_i = a parameter denoting the fraction of precipitation that is intercepted and is set at a
24 value of 0.3 following Bugmann & Cramer (1998), and P_m = the monthly precipitation.

$$25 \quad Precip_{s\ m} = P_m - Precip_{i\ m} \quad \text{eqn S5}$$

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27 **References**

28 Bugmann, H. & Cramer, W. (1998) Improving the behaviour of forest gap models along
29 drought gradients. *Forest Ecology and Management*, **103**, 247-263.

30 Turc, L. (1961) Evaluation des besoins en eau d'irrigation, évapotranspiration potentielle.
31 *Annales Agronomiques*, **12**, 13-49.

32 **Appendix S2** Likelihood of the model and prior description.

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34 The likelihood of the observed five years radial growth (y_{pi}) based on a log-normal
35 distribution of mean G_{pi} (see eqn 1) and variance σ^2 is given by eqn S6.

$$36 \quad L(Y | X, \sigma^2) = \prod_{p=1}^P \prod_{i=1}^{N_p} \text{LN}(y_{pi} | G_{pi}, \sigma^2) \quad \text{eqn S6}$$

37 We used flat conjugate prior with inverse-gamma distribution for variance σ^2 and conjugate
38 log-normal prior for $\alpha_p, \beta_1, \beta_2,$ and β_3 and non informative unconjugate prior for γ and δ . The
39 first level priors were log-normal prior for β $p(\log(\beta_k)) = N(\text{mean}=0, \text{precision}=0.000001)$,
40 inverse-gamma for σ^2 $p(\sigma^2) = IG(1,0.1)$, a uniform prior for γ , a normal prior for δ
41 $p(\delta) = N(\text{mean} = 0, \text{precision} = 0.000001)$. α_p was modelled as a random log-normal variable
42 accounting for plot effect, with mean α and variance V_p ($p(\alpha_p) = \text{LN}(\alpha, V_p)$). The second
43 level priors were a flat inverse-gamma prior $p(V_p) = IG(1,0.1)$ and non informative log-
44 normal prior $p(\log(\alpha)) = N(\text{mean} = 0, \text{precision} = 0.000001)$.

45 To keep the parameters within a biologically meaningful range and to help MCMC
46 convergence we bounded prior within a plausible range of values. Studies have generally
47 concluded that there is a positive effect of degree-day sum (DD), and a negative effect of
48 drought, on tree growth (see Rickebusch *et al.* 2007). We therefore decided to constrain our
49 estimation to have a positive effect of both DD and WB by setting a positive boundary to the
50 prior.

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52 **References**

53 Rickebusch, S., Lischke, H., Bugmann, H., Guisan, A. & Zimmermann, N.E. (2007)

54 Understanding the low-temperature limitations to forest growth through calibration of forest
55 dynamics models with tree-ring data. *Forest Ecology and Management*, **246**, 251-263.

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57 **Table S1:** Year of data collection and area for each *Département*.

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Département	Year of data collection	Area (km²)
1	1995	5762
4	1999	6925
5	1997	5549
6	2002	4299
25	1994	5234
26	1996	6530
38	1997	7431
39	1992	4999
73	2000	6028
74	1998	4388
83	1999	5973
84	2001	3567

65 **Table S2.** Parameter estimates of the growth model (see eqn 1 for details): mean posterior values (and 95% posterior credible intervals) for the fixed-
 66 effects of the best model (see Table 2). ‡ indicates that the parameter was not estimated for this species. For species acronyms, see Table 1.

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Species	α	β_1	β_2	β_3	γ	δ	δ_1	δ_2
ABIALB	2.56 (2.01 - 3.47)	0.42 (0.41 - 0.44)	0.15 (0.11 - 0.19)	0.14 (0.11 - 0.17)	0.17 (0.09 - 0.25)	1.05 (0.86 - 1.27)	0.1 (0.02 - 0.19)	‡
FAGSIL	0.96 (0.87 - 1.09)	0.43 (0.42 - 0.44)	0.07 (0.03 - 0.1)	0.08 (0.06 - 0.1)	0.34 (0.26 - 0.4)	1.04 (0.87 - 1.23)	-0.29 (-0.38 - -0.2)	0.15 (0.06 - 0.26)
PICABI	3.08 (2.5 - 3.95)	0.44 (0.43 - 0.45)	0.3 (0.24 - 0.35)	0.13 (0.1 - 0.16)	0.09 (0.05 - 0.14)	0.91 (0.8 - 1.02)	0.16 (0.11 - 0.21)	0 (-0.03 - 0.04)
PINSYL	1.07 (0.94 - 1.24)	0.1 (0.09 - 0.11)	0 (0 - 0.01)	0.01 (0 - 0.03)	0.18 (0.12 - 0.25)	0.85 (0.72 - 0.99)	‡	‡
LARDEC	1.67 (1.14 - 2.6)	0.26 (0.24 - 0.27)	0.15 (0.08 - 0.25)	0.06 (0.03 - 0.09)	0.1 (0.02 - 0.25)	0.6 (0.45 - 0.8)	0.12 (0.04 - 0.23)	‡
QUEPET	1.62 (1.16 - 2.22)	0.44 (0.42 - 0.46)	0.12 (0.09 - 0.15)	0.07 (0.03 - 0.12)	0.05 (0.02 - 0.13)	0.59 (0.48 - 0.73)	‡	-0.02 (-0.07 - 0.02)
QUEPUB	0.5 (0.46 - 0.54)	0.19 (0.18 - 0.2)	0.1 (0.08 - 0.11)	0.04 (0.02 - 0.07)	0.34 (0.27 - 0.42)	0.72 (0.6 - 0.86)	‡	0.2 (0.1 - 0.31)
QUEROB	1.86 (1.22 - 3.43)	0.33 (0.29 - 0.36)	0.17 (0.09 - 0.26)	0.03 (0 - 0.07)	0.13 (0.01 - 0.34)	0.59 (0.42 - 0.82)	0.02 (-0.09 - 0.14)	‡
QUEILE	0.46 (0.42 - 0.51)	0.15 (0.14 - 0.16)	0.14 (0.11 - 0.17)	0.09 (0.06 - 0.11)	0.18 (0.03 - 0.46)	0.13 (0.06 - 0.19)	‡	‡
PINCEM	1.4 (0.64 - 3.19)	0.01 (-0.08 - 0.09)	0.04 (0 - 0.11)	0.13 (0.02 - 0.26)	0.17 (0.01 - 0.58)	0.8 (0.46 - 1.3)	‡	‡
PINUNC	0.86 (0.58 - 1.45)	0.1 (0.07 - 0.14)	0.03 (0 - 0.08)	0.09 (0.04 - 0.15)	0.22 (0.05 - 0.43)	1 (0.66 - 1.46)	‡	‡
POPTRE	1.84 (1.24 - 3.38)	0.28 (0.24 - 0.32)	0.09 (0.03 - 0.15)	0.08 (0.02 - 0.13)	0.17 (0.02 - 0.35)	0.81 (0.54 - 1.13)	‡	‡
ACEg	1.56 (1.09 - 2.37)	0.26 (0.23 - 0.29)	0.05 (0.01 - 0.11)	0.12 (0.08 - 0.16)	0.19 (0.05 - 0.38)	0.85 (0.61 - 1.18)	0.03 (-0.1 - 0.17)	
BETPUB	1.65 (1.11 - 2.64)	0.1 (0.05 - 0.15)	0.03 (0 - 0.08)	0.1 (0.02 - 0.19)	0.15 (0.03 - 0.33)	0.77 (0.54 - 1.04)	‡	0.08 (-0.07 - 0.27)
CARBET	1.16 (0.87 - 1.68)	0.3 (0.29 - 0.31)	0.1 (0.07 - 0.13)	0.08 (0.04 - 0.13)	0.15 (0.05 - 0.26)	0.9 (0.69 - 1.13)	‡	-0.01 (-0.12 - 0.07)
FRA	1.66 (1.23 - 2.41)	0.36 (0.34 - 0.38)	0.07 (0.04 - 0.1)	0.11 (0.08 - 0.15)	0.14 (0.04 - 0.25)	0.77 (0.57 - 1)	‡	‡

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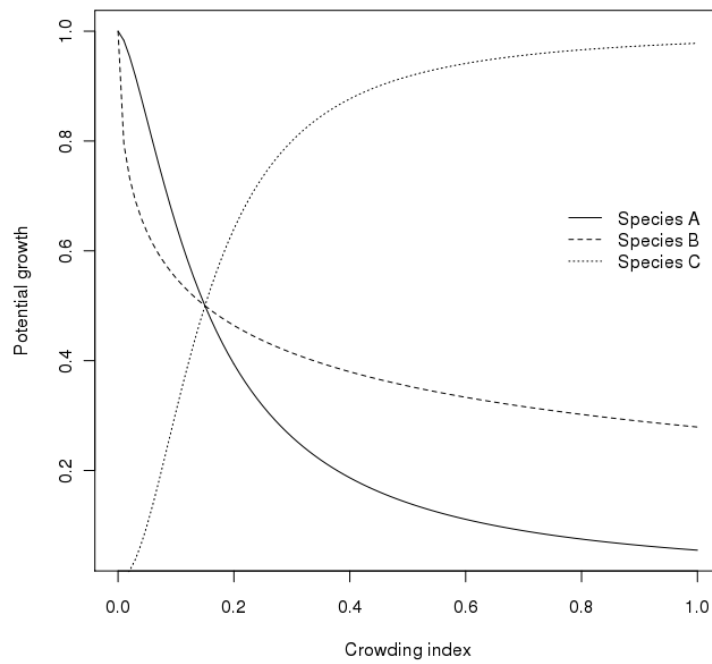
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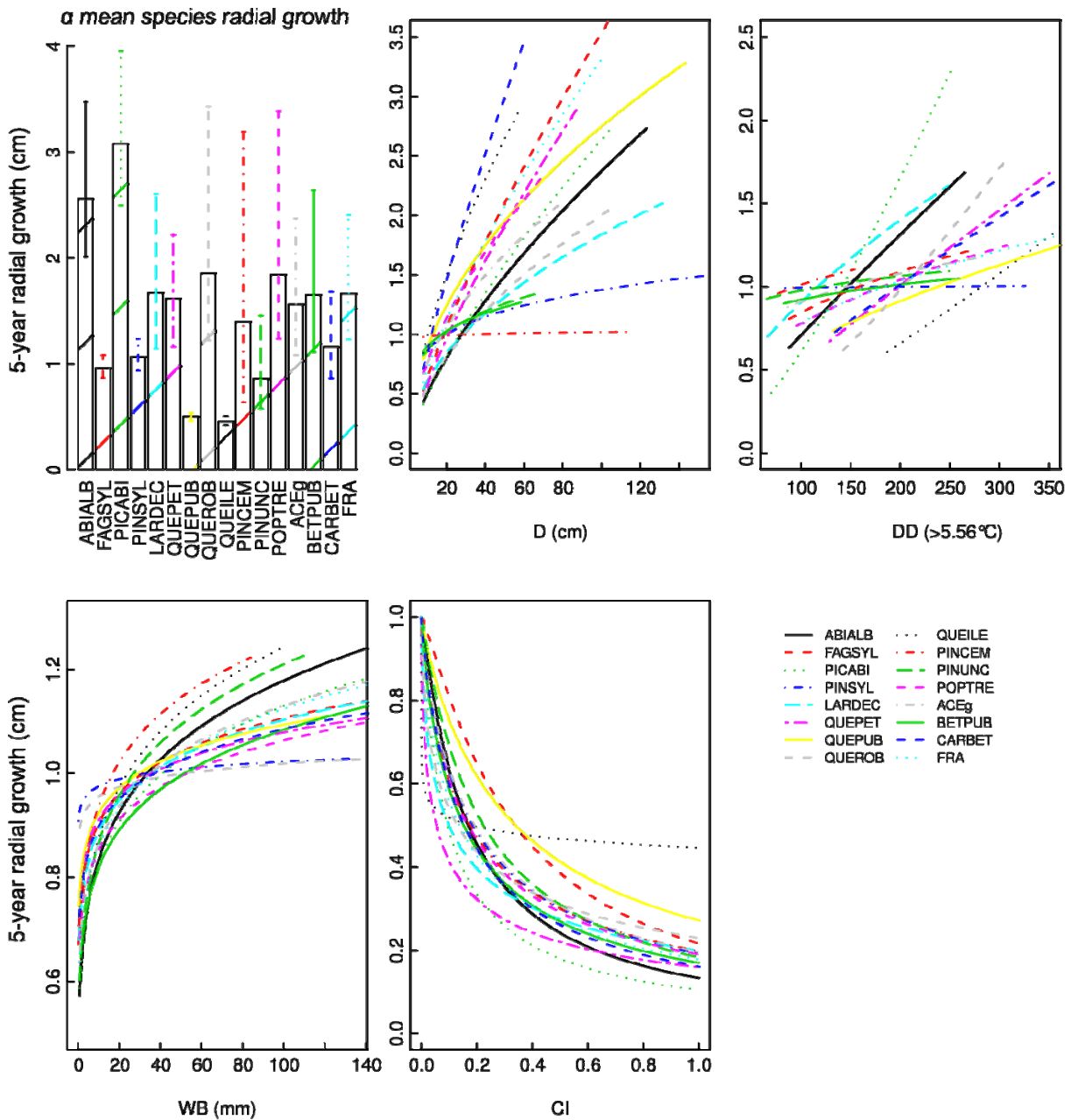
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75 **Fig. S1.** Effect of neighbourhood crowding on potential growth for three hypothetical species.
76 Species A exhibits a very strong decrease of potential growth at high crowding index ($\delta=1.5$
77 and $\gamma=0.15$), whereas Species B exhibits a much smaller reduction of potential growth ($\delta=0.5$
78 and $\gamma=0.15$). Finally, Species C exhibits a positive crowding effect (i.e. facilitation) ($\delta=-2$ and
79 $\gamma=0.15$). The crowding reduction function and crowding index range between 0 and 1. See
80 text for more details on the crowding function.



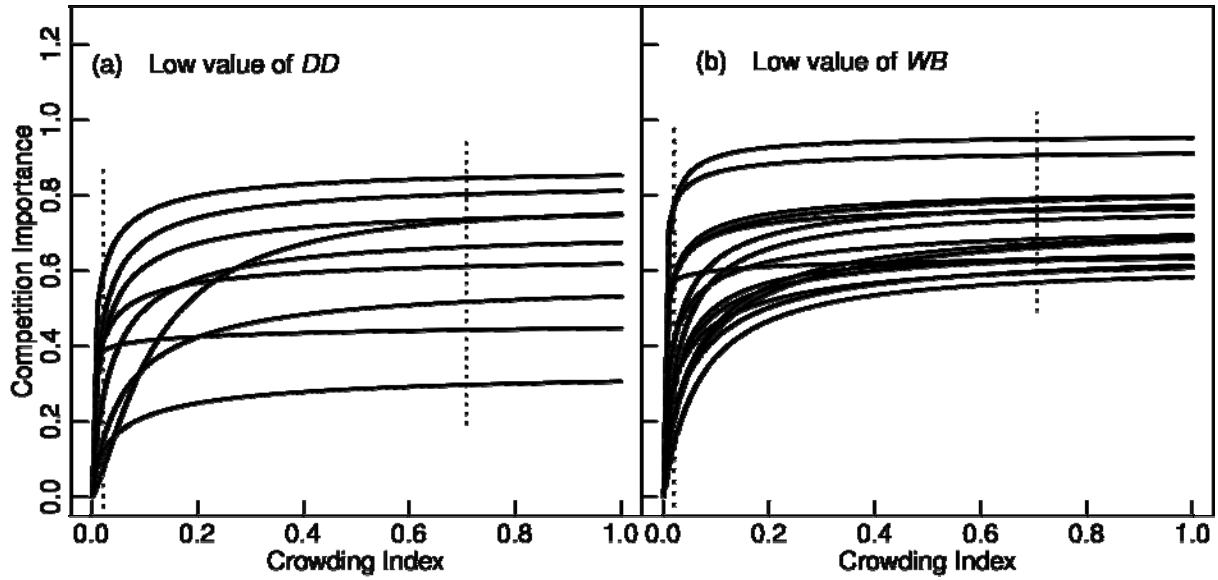
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Fig S2. Growth response curves. For each of the 16 studies species, growth parameters α (and 95% credible intervals) (a), and growth curves showing the effect of (b) diameter (D), (c) degree-day sum (DD), (d) water budget (WB) and (e) crowding index (CI), for the 16 studied species. See Table 1 for species acronyms.



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102 **Fig. S3.** Variation in competition importance with crowding index at low values of degree-
103 day sum (DD) (high stress) (a) and low value of water budget (WB) (high stress) (b). Vertical
104 dotted lines represents positions of low and high crowding conditions (CI of 0.02 and 0.7
105 respectively) used in Figs. 6 and 7 in the main text.



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