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Supplementary file. Additional information on LPJ-GUESS parameterization, input data and results.

Species characterization in LPJ-GUESS (see also Hickler et al. 2012)

Trees establish under suitable temperature ($T_{c,min}$, $T_{c,max}$ and $GDD_{5,min}$), soil moisture (awc_{min}) and light conditions (par_{min}) which differ for each species (Table S1). The number of actual saplings is drawn from a Poisson distribution with a species-specific expectation (a function of maximum establishment rate est_{max} and constant α, Table S1). Each sapling is then allocated an initial biomass and size for the first year.

Table S1. Selected species-specific parameters in LPJ-GUESS for *P. sylvestris*, *P. abies* and *B. pubescens*, affecting the competition between these three species.

parameter	meaning	*P. sylvestris*	*P. abies*	*B. pubescens*
shade_ tolerance	shade tolerance class; determines par_{min}, est_{max}, α, $turn_{sapwood}$, greff	intermediate	tolerant	intolerant
establishment				
$T_{c,min}$	min. coldest month mean temperature [°C] [1]	-29	-29	-
$T_{c,max}$	max. coldest month mean temperature [°C] [1]	-1.0	-1.5	-
$GDD_{5,min}$	min. growing degree days (5°C)	500	600	350
awc_{min}	min. fraction of plant-available water content [2]	0.25	0.43	0.5
par_{min}	min. forest floor PAR [3] [MJ m^{-2} day^{-1}]	2.0	1.25	2.5
est_{max}	max. establishment rate [saplings m^{-2} $year^{-1}$]	0.1	0.05	0.2
α	recruitment shape parameter; negatively affects establishment rate as canopy closes	6	2	10
growth				
$k_{la:sa}$	leaf area to cross-sectional area ratio	2000	4000	5000
k_{allom1}	allometric constant; affects crown area	150	150	250
SLA	specific leaf area [m^2 kgC^{-1}]	9.3	9.3	24.3
a_{leaf}	leaf longevity [years]	2	4	0.5
k_{chillb}	chilling requirement for budburst (constant)	100	100	400
$turn_{leaf}$	leaf turnover ratio	0.5	0.25	1.0
$turn_{sapwood}$	sapwood to heartwood turnover ratio	0.065	0.05	0.08
z_1	fraction of roots in upper soil layer	0.6	0.8	0.8
k_{uptake}	shape parameter of water uptake function	0.5	0.86	1.0
mortality				
a_{ind}	max. non-stressed longevity [years]	500	500	200
greff	growth efficiency parameter [g C m^{-2} $leaf^{-1}$ $year^{-1}$]; defines inflection point of sigmoid mortality function	80	40	100
$T_{c,min}$	min. coldest month mean temperature [°C] [1]	-30	-30	-
r_{fire}	probability of surviving fires	0.4	0.1	0.1

[1] over the last 20 years [2] growing-season average in the upper soil layer [3] photosynthetically active radiation

Trees grow in biomass, height, and diameter as the net primary production accrued by an average individual per simulation year is allocated to leaves, fine roots, and sapwood, following a set of prescribed allometric relationships (Sitch et al. 2003). Species-specific parameters affecting growth (Table S1) describe the growth form ($k_{la:sa}$, k_{allom1}), foliage (SLA, a_{leaf}), phenology (k_{chillb}), tissue turnover ($turn_{leaf}$, $turn_{sapwood}$) as well as soil water uptake and thus drought resistance (z_1, k_{uptake}) of each species.

Tree mortality in LPJ-GUESS is caused by i) background mortality related to species longevity (a_{ind}), ii) low growth efficiency ($greff$), which is strongly influenced by competition, particularly for light, iii) winter temperatures falling below a species-specific limit ($T_{c,min}$), and iv) fire (r_{fire}, Table S1).

The following parameters are determined by higher-level classification and thus do not differ between the three tree species investigated in this study. All three species are *trees* and thus share the C3 photosynthetic pathway where photorespiration reduces the efficiency of photosynthesis. Thus, these species are more sensitive to CO_2 increase, which could enhance their productivity as opposed to e.g. tropical grasses with the C4 pathway. They are also all *boreal* species sharing higher respiration rates and lower optimum temperatures for photosynthesis compared to temperate species.

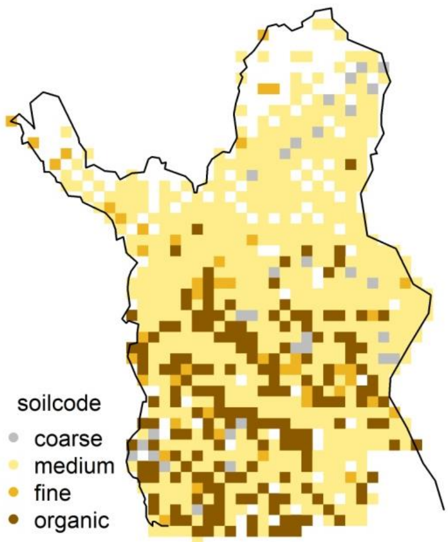

Fig. S1: Map of the soil characteristics classified into the nine-class soil code of LPJ-GUESS (Sitch et al. 2003, Table 4).

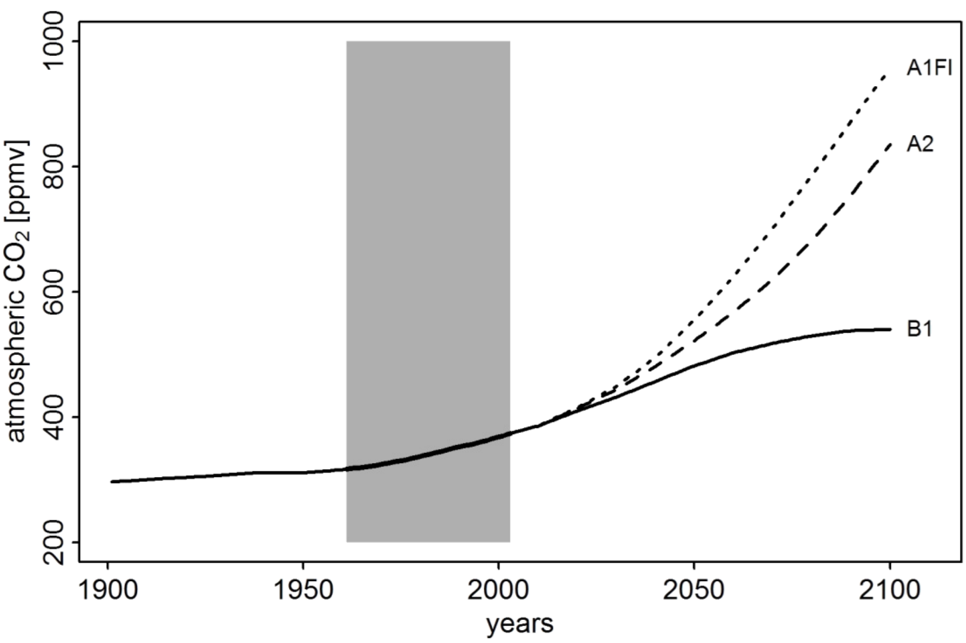

Fig. S2: Atmospheric CO_2 content [ppmv] used as LPJ-GUESS input (annual values). Our simulation period is highlighted as grey box. For reference, predicted future CO_2 concentrations are shown for emission scenarios A1FI (fossil fuel intensive), A2 and B1 (Nakicenovic et al. 2000).

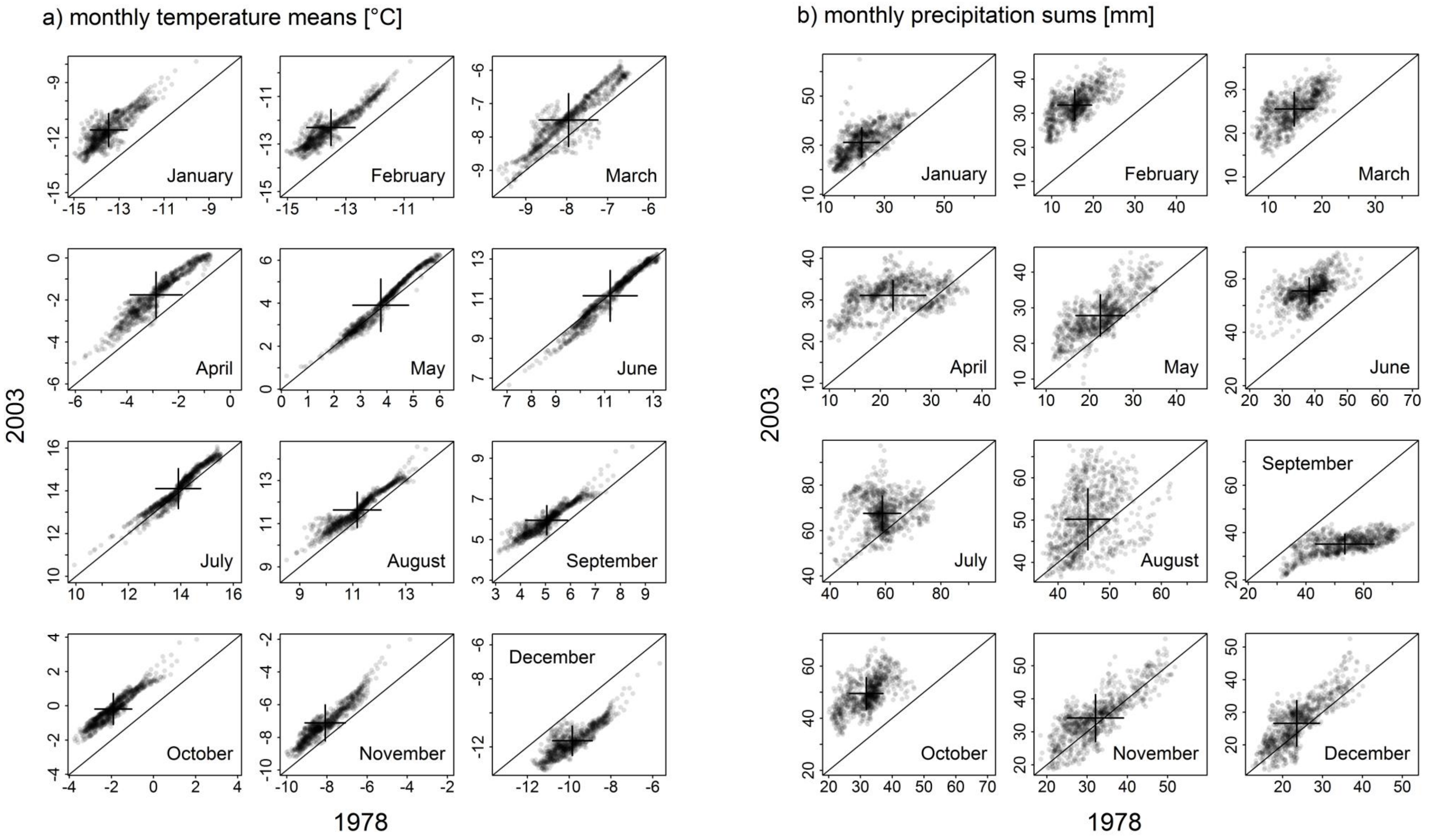

Fig. S3: Comparison of a) monthly mean temperatures and b) monthly precipitation sums between 1978 (1968-1977) and 2003 (1993-2002). Plus signs indicate median (intersection) and standard deviation (length of the arms). The difference between 1978 and 2003 is significant in all cases ($p < 0.001$, Wilcoxon rank sum test).

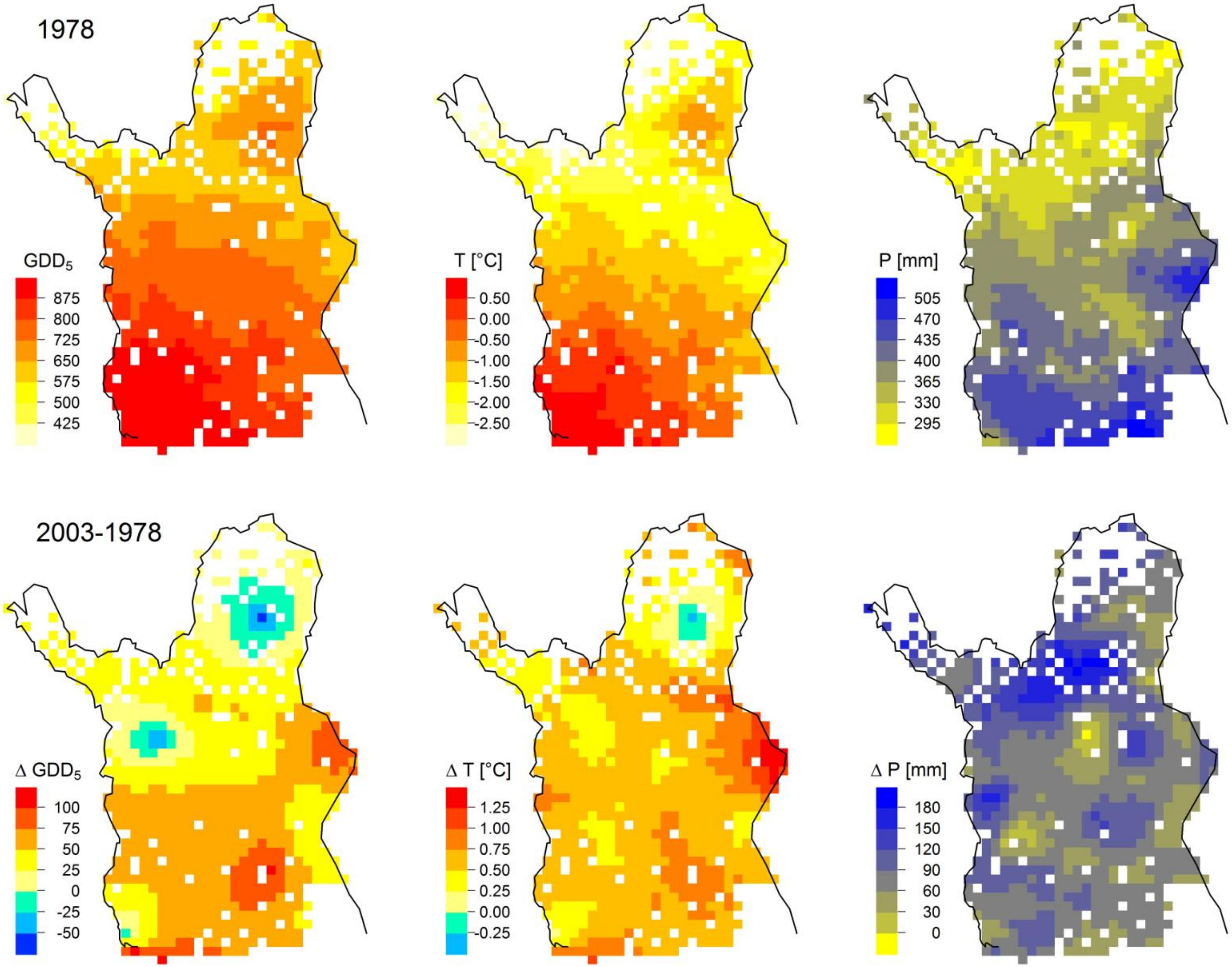

Fig. S4: Maps of growing degree days (5°C), annual mean temperature [°C] and annual precipitation sum [mm] in 1978 (upper row) and changes from 1978 to 2003 (lower row).

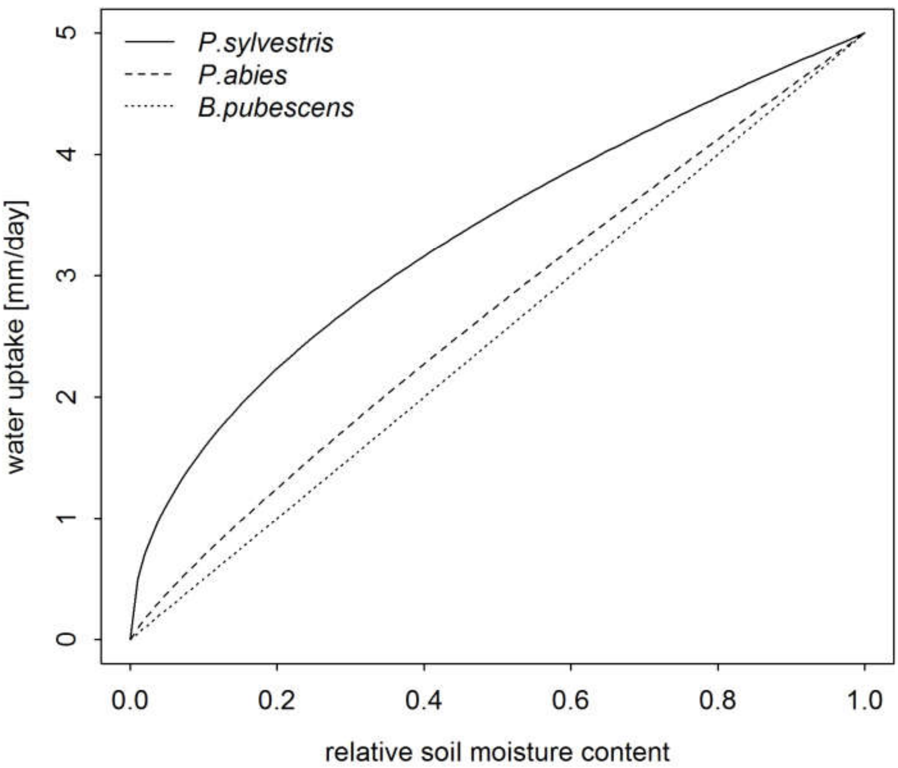

Fig. S5: Water uptake as a function of relative soil moisture content (Schurgers, et al. 2011), parameterized for *P. sylvestris* (k_{uptake} = 0.5), *P. abies* (k_{uptake} = 0.86), and *B. pubescens* (k_{uptake} = 1.0, Table S1).

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