

Global ecological drivers of transpiration regulation in trees

DOCTORADO EN ECOLOGIA TERRESTRE

Centre de Recerca Ecològica i Aplicacions Forestals

Autonomous University of Barcelona

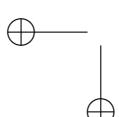
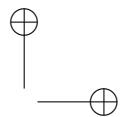
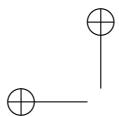
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Víctor Flo Sierra

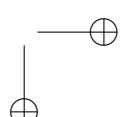
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Dec 2020



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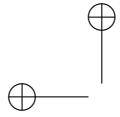
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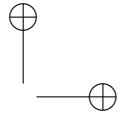
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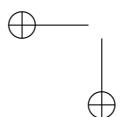


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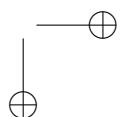
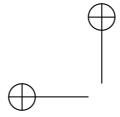
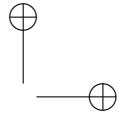


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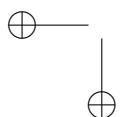


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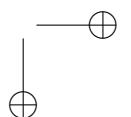


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Abstract

Understanding how climate affects species' distribution and performance is a central issue in ecology since its origins. In last decades, however, the interest in this question has been reactivated by the current context of climate change. Species Niche Modelling has been widely used to assess shifts in species distribution and to test the relationship between species' climatic niche and species physiological and demographic performance, implicitly assuming that species occurrence portrays the environmental and biotic species' suitable conditions. Nevertheless it is still largely undetermined whether these models can portray population and community responses, particularly in relation to extreme climatic episodes.

In this thesis I aim at exploring the capacity of niche modelling to predict species decay under extreme climatic conditions, particularly droughts, addressing some constraints of this approach and proposing possible solutions. To achieve this goal, I counted with 3 vegetation decay datasets measured in the Spanish SE after the extreme drought year 2013-2014. Two of these datasets were based on defoliation sampling of individual plants belonging to more than 40 semiarid shrubland species (chapters 2, 4 and 5), while the other one was based on regional compiled data of *Pinus halepensis* L. affection in plots of 1km^2 (chapter 3). In second chapter I used different Species Distribution Model (SDMs) algorithms to estimate species' climatic suitability before (1950-2000) and during the extreme drought, in order to test the possible correlation between suitability and decay, and whether the existence of this relationship depended on the applied SDM algorithm. I consistently found a

positive correlation between remaining green canopy and species' climatic suitability before the event, suggesting that populations historically living closer to their species' tolerance limits are more vulnerable to drought. Contrastingly, decreased climatic suitability during the drought period did not correlate with remaining green canopy, likely because of extremely low climatic suitability values achieved during the exceptional climatic episode. In order to test whether this extremely low suitability values could derive as a consequence of only considering climatic averages when calibrating SDMs, in the third chapter I developed a method to include inter-annual climatic variability into niche characterization. I then compared the respective capacities of climatic suitabilities obtained from averaged-based and from inter-annual variability-based niches to explain demographic responses to extreme climatic events. I found that climatic suitability obtained from both niches quantifications significantly explained species demographic responses. However, climatic suitability from inter-annual variability-based niches showed higher explanatory capacity, especially for populations that tend to be more geographically marginal. In the fourth chapter I tried to overcome the inability of the SDMs to predict populations decay during extreme conditions, as observed in the second chapter, by using Euclidean distances to species' niche in the environmental space. I compared the capacities of both population distances in the climatic environmental space and population climatic suitability derived from SDMs to explain population observed physiological and demographic responses to an extreme event. Additionally, I tested such relationship in populations located in three different bedrock sites, corresponding to a gradient of water availability. I found that SDMs-derived suitability failed to explain population decay while distances to the niche centroid and limit significantly explained population die-off, highlighting that population displaced farther from species' niche during the extreme episode showed higher vulnerability to drought. The results also suggested a relevant role of some bedrocks buffering species decay responses to extreme drought events mainly according to soil water holding capacity. Finally, in the fifth chapter, I used species niche characterizations in the environmental space and demographic data to address the impact of extreme events

at community level. Particularly, I estimated the community climatic disequilibrium before and after a drought episode along a gradient of water availability in three bedrock types. Disequilibrium was computed as the difference between observed climate and community-inferred climate, which was calculated as the mean of species' climatic optimum weighted by species abundance collected in field surveys. I found that extreme drought nested within a decadal trend of increasingly aridity led to a reduction in community climatic disequilibrium, particularly when combined with low water-retention bedrocks. In addition, community climatic disequilibrium also varied before the extreme event across bedrock types, according to soils water-retention capacity. In conclusion, by developing different techniques, derived from species distribution, that characterize climatic accuracy at population and community level, this work reveals the capacity of species climatic niche to explain demographic responses under climate change-induced episodes of extreme drought.

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— “*No one will protect what they don’t care about;
and no one will care about what they have never experienced*” —

David Attenborough

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1

division: ‘Biology’

Placeholder

-
- 1.0.1 Sap flow calibration datasets
 - 1.0.2 Calibration assessment
 - 1.0.3 Statistical analyses
 - 1.0.4 Calibration performance compared among methods and families of methods
 - 1.0.5 Influence of wood traits
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A

Appendix Chapter 2

A.1 Figures A

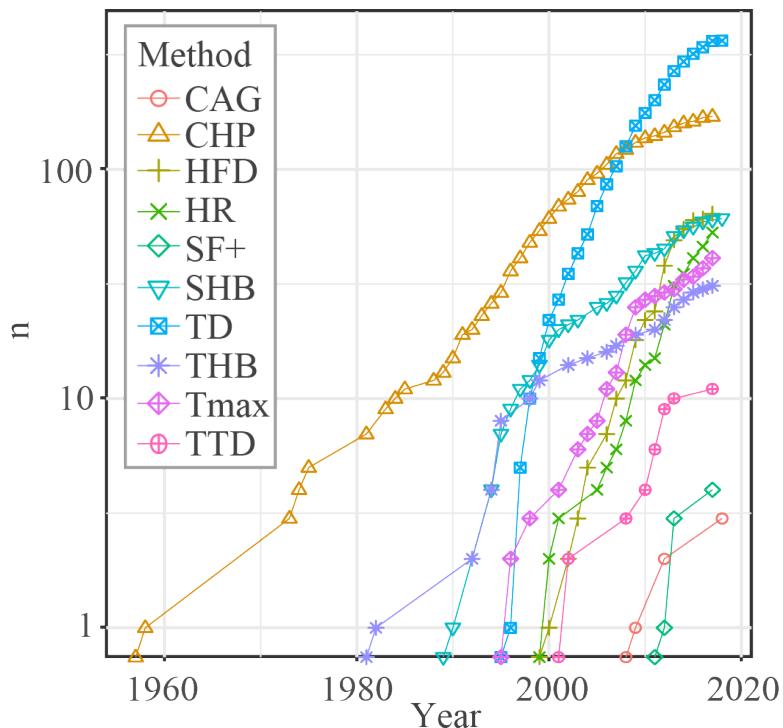


Figure A.1: Representation of the cumulative number of studies using different sap flow methods between 1957 and 2017 (adapted and updated from Poyatos et al. 2016). CAG: calibrated average gradient; CHP: compensation heat pulse (early heat pulse methods have been considered CHP, Edwards et al. 1997); HFD: head field deformation; HR: heat ratio, SF+: sapflow+; SHB: stem heat balance; TD: thermal dissipation; THB: trunk heat balance; Tmax: T-max heat pulse; TTD: transient thermal dissipation. Notice the logarithmic scale on the y-axis.

A.1. Figures A

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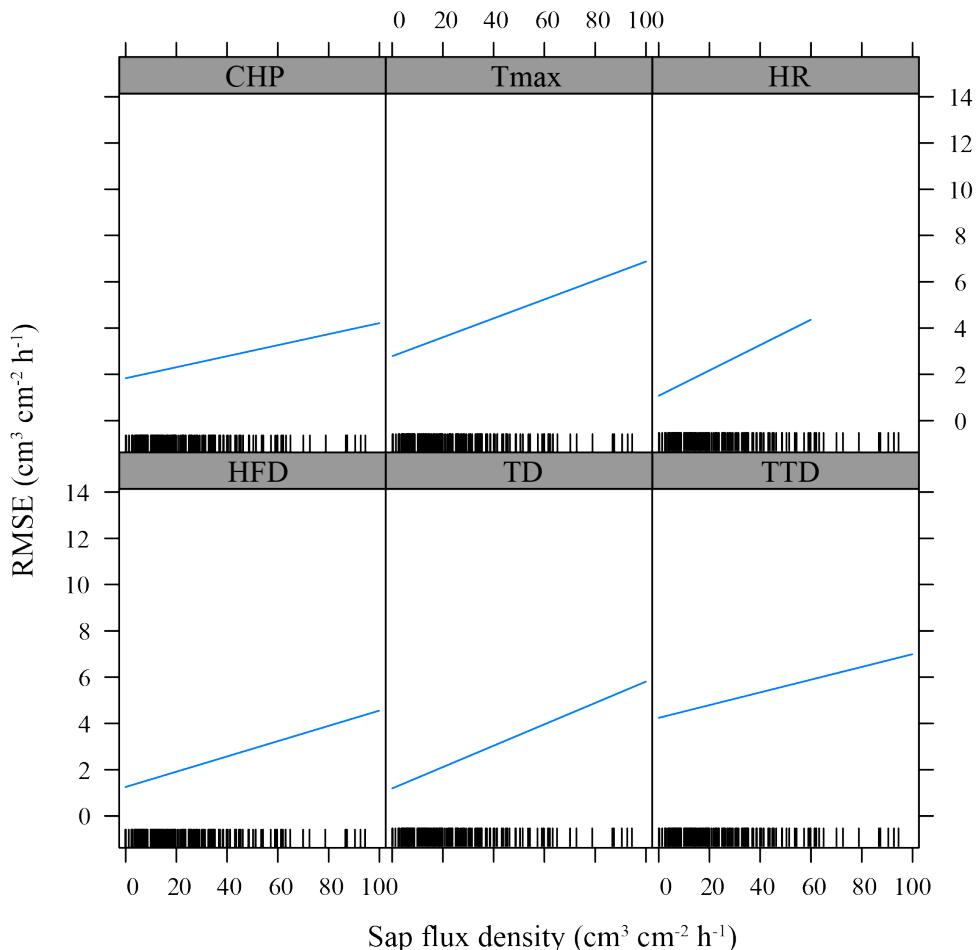


Figure A.2: Relationship between root mean square error (RMSE) and sap flux density (mean calibration range) and for different sap flux density methods, as predicted by the LMM model presented in Table 3.

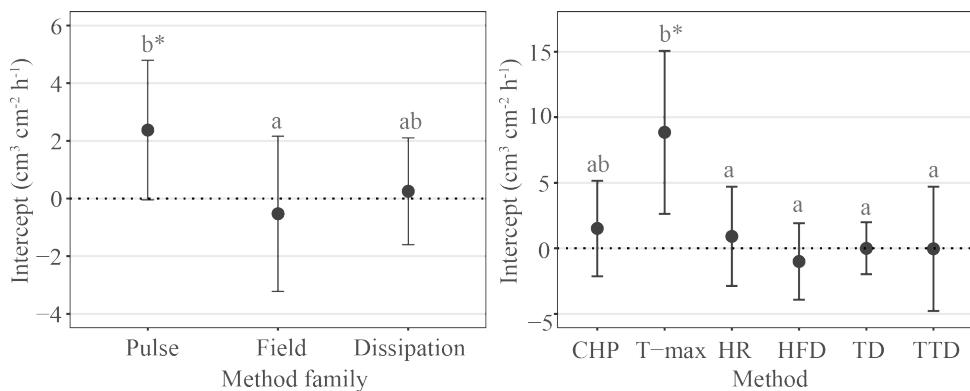


Figure A.3: Predictions of the LMM models calculated from least-squares means of the intercept (β_0) of the linear model (Eq. 3). Different letters indicate significant differences between factors levels evaluated with Tukey’s test. Horizontal, dotted lines indicate reference, perfect calibration values for a given metric. Asterisks (*) indicate significant ($p < 0.05$) departure from those reference values.

A.2 Tables A

A.2 Tables A

Table A.1: Summary table of the studies used in the analyses presented in the paper. Sap flow method, species, calibration material, porosity and average stem/tree diameter are reported.

Study	Method	Species	Calibration material	Wood porosity	Diameter (cm)
Alarcon <i>et al.</i> 2005	CHP	<i>Citrus limon</i>	whole plant	Diffuse porous	2.50
Ballester <i>et al.</i> 2011	CHP	<i>Citrus clementina</i>	whole plant	Diffuse porous	NA
Barret <i>et al.</i> 1995	CHP	<i>Corymbia maculata</i>	without roots	Diffuse porous	NA
Bleby <i>et al.</i> 2004	CHP	<i>Eucalyptus marginata</i>	whole plant	Diffuse porous	10.00
Bleby <i>et al.</i> 2004	HR	<i>Eucalyptus marginata</i>	whole plant	Diffuse porous	10.00
Braun and Schmid 1999	TD	<i>Vitis vinifera</i>	whole plant	Ring porous	3.75
Burgess <i>et al.</i> 2001	HR	<i>Eucalyptus marginata</i>	whole plant	Diffuse porous	NA
Bush <i>et al.</i> 2010	TD	<i>Populus fremontii</i>	stem segment	Diffuse porous	5.08
Bush <i>et al.</i> 2010	TD	<i>Tilia cordata</i>	stem segment	Diffuse porous	4.83
Cain 2009	TD	<i>Macaranga hypoleuca</i>	stem segment	Diffuse porous	82.00
Cain 2009	TD	<i>Macaranga pearsonii</i>	stem segment	Diffuse porous	67.00
Caspari <i>et al.</i> 1993	CHP	<i>Pyrus serotina</i>	whole plant	Diffuse porous	6.62
Caterina <i>et al.</i> 2013	TD	<i>Juniperus virginiana</i>	stem segment	Tracheids	8.00
Chan 2015	TD	<i>Abies concolor</i>	stem segment	Tracheids	6.00
Cohen <i>et al.</i> 1981	T-max	<i>Platanus orientalis</i>	stem segment	Diffuse porous	6.70
Cohen <i>et al.</i> 1981	T-max	<i>Populus alba</i>	stem segment	Diffuse porous	6.70
Cohen <i>et al.</i> 1998	T-max	<i>Malus domestica</i>	whole plant	Diffuse porous	NA
Dragoní <i>et al.</i> 2005	CHP	<i>Malus domestica</i>	whole plant	Diffuse porous	6.50
Dye <i>et al.</i> 1996	CHP	<i>Pinus patula</i>	without roots	Tracheids	NA
Fernandez <i>et al.</i> 1999	CHP	<i>Olea europaea</i>	stem segment	Diffuse porous	8.80
Fernandez <i>et al.</i> 1999	CHP	<i>Olea europaea</i>	without roots	Diffuse porous	NA
Fernandez <i>et al.</i> 2006	CHP	<i>Citrus sinensis</i>	stem segment	Diffuse porous	7.80
Fernandez <i>et al.</i> 2006	CHP	<i>Citrus sinensis</i>	without roots	Diffuse porous	10.40
Fernandez <i>et al.</i> 2006	CHP	<i>Olea europaea</i>	stem segment	Diffuse porous	8.20
Fernandez <i>et al.</i> 2006	CHP	<i>Olea europaea</i>	without roots	Diffuse porous	9.80
Fernandez <i>et al.</i> 2006	CHP	<i>Prunus domestica</i>	stem segment	Diffuse porous	8.00
Fernandez <i>et al.</i> 2006	CHP	<i>Prunus domestica</i>	without roots	Diffuse porous	7.00
Fuchs <i>et al.</i> 2017	HFD	<i>Acer pseudoplatanus</i>	stem segment	Diffuse porous	10.56
Fuchs <i>et al.</i> 2017	HFD	<i>Fagus sylvatica</i>	stem segment	Diffuse porous	9.42
Fuchs <i>et al.</i> 2017	HFD	<i>Tilia cordata</i>	stem segment	Diffuse porous	9.29
Fuchs <i>et al.</i> 2017	HR	<i>Acer pseudoplatanus</i>	stem segment	Diffuse porous	NA
Fuchs <i>et al.</i> 2017	HR	<i>Fagus sylvatica</i>	stem segment	Diffuse porous	NA
Fuchs <i>et al.</i> 2017	HR	<i>Tilia cordata</i>	stem segment	Diffuse porous	NA
Fuchs <i>et al.</i> 2017	TD	<i>Acer campestre</i>	stem segment	Diffuse porous	11.81
Fuchs <i>et al.</i> 2017	TD	<i>Acer pseudoplatanus</i>	stem segment	Diffuse porous	10.80
Fuchs <i>et al.</i> 2017	TD	<i>Fagus sylvatica</i>	stem segment	Diffuse porous	9.83
Fuchs <i>et al.</i> 2017	TD	<i>Populus nigra</i>	stem segment	Diffuse porous	10.77
Fuchs <i>et al.</i> 2017	TD	<i>Tilia cordata</i>	stem segment	Diffuse porous	9.41
Gonzalez-Altozano <i>et al.</i> 1998	CHP	<i>Citrus reticulata</i>	whole plant	Diffuse porous	11.50
Gonzalez-Altozano <i>et al.</i> 1998	T-max	<i>Citrus reticulata</i>	whole plant	Diffuse porous	11.50
Granier 1985	TD	<i>Pinus nigra</i>	stem segment	Tracheids	4.50
Granier 1985	TD	<i>Pseudotzuga menziesii</i>	stem segment	Tracheids	4.50
Granier 1985	TD	<i>Quercus pedunculata</i>	stem segment	Ring porous	4.50

Table A.1: Summary table of the studies used in the analyses presented in the paper. Sap flow method, species, calibration material, porosity and average stem/tree diameter are reported. (*continued*)

Study	Method	Species	Calibration material	Wood porosity	Diameter (cm)
Green <i>et al.</i> 1988	CHP	<i>Actinidia chinensis</i>	stem segment	Diffuse porous	5.25
Green <i>et al.</i> 1988	CHP	<i>Actinidia chinensis</i>	whole plant	Diffuse porous	5.40
Green <i>et al.</i> 1988	CHP	<i>Malus sylvestris</i>	whole plant	Diffuse porous	5.60
Gutierrez <i>et al.</i> 1994	SHB	<i>Acacia koa</i>	whole plant	Diffuse porous	NA
Gutierrez <i>et al.</i> 1994	SHB	<i>Coffea arabica</i>	whole plant	Diffuse porous	NA
Gutierrez Soto <i>et al.</i> 2012	HR	<i>Carica papaya</i>	whole plant	Monocot	NA
Hatton <i>et al.</i> 1995	CHP	<i>Eucalyptus populnea</i>	without roots	Diffuse porous	5.40
Heilman <i>et al.</i> 1990	SHB	<i>Ligustrum japonicum</i>	whole plant	Diffuse porous	1.00
Herbs <i>et al.</i> 2007	TD	<i>Acer campestre</i>	stem segment	Diffuse porous	NA
Herbs <i>et al.</i> 2007	TD	<i>Crataegus monogyna</i>	stem segment	Diffuse porous	NA
Hultine <i>et al.</i> 2010	TD	<i>Tamarix ramosissima</i>	stem segment	Ring porous	4.16
Intrigliolo <i>et al.</i> 2009	T-max	<i>Vitis vinifera</i>	whole plant	Ring porous	NA
Isarangkool <i>et al.</i> 2009	TTD	<i>Abies concolor</i>	stem segment	Diffuse porous	5.14
Isarangkool <i>et al.</i> 2009	TTD	<i>Hevea brasiliensis</i>	stem segment	Diffuse porous	4.69
Isarangkool <i>et al.</i> 2009	TTD	<i>Mangifera indica</i>	stem segment	Diffuse porous	4.35
Johan Uddling <i>et al.</i> 2009	TD	<i>Betula papyrifera</i>	stem segment	Diffuse porous	NA
Lu 2002	TD	<i>Garcinia mangostana</i>	whole plant	Diffuse porous	4.00
Lu 2002	TD	<i>Mangifera indica</i>	whole plant	Diffuse porous	2.30
Lu 2002	TD	<i>Musa spp.</i>	whole plant	Monocot	12.00
Lu and Chacko 1998	TD	<i>Mangifera indica</i>	whole plant	Diffuse porous	2.30
Madurapperuma <i>et al.</i> 2009	HR	<i>Syagrus romanzoffiana</i>	whole plant	Monocot	NA
Michell <i>et al.</i> 2009	HR	<i>Eucalyptus capillosa</i>	without roots	Diffuse porous	6.50
Montague <i>et al.</i> 2006	TD	<i>Liquidambar styraciflua</i>	whole plant	Diffuse porous	5.30
Montague <i>et al.</i> 2006	TD	<i>Populus deltoides</i>	whole plant	Diffuse porous	5.60
Montague <i>et al.</i> 2006	TD	<i>Pyrus calleryana</i>	whole plant	Diffuse porous	6.60
Montague <i>et al.</i> 2006	TD	<i>Quercus robur x Q. Bicolor</i>	whole plant	Ring porous	5.70
Nadezhina <i>et al.</i> 1998	HFD	<i>Tilia cordata</i>	without roots	Diffuse porous	12.00
Nortes <i>et al.</i> 2009	CHP	<i>Prunus dulcis</i>	whole plant	Diffuse porous	15.00
Paudel <i>et al.</i> 2013	TD	<i>Malus domestica</i>	stem segment	Diffuse porous	4.01
Paudel <i>et al.</i> 2013	TD	<i>Peltophorum dubium</i>	stem segment	Diffuse porous	3.70
Paudel <i>et al.</i> 2013	TD	<i>Prunus persica</i>	stem segment	Diffuse porous	4.00
Paudel <i>et al.</i> 2013	TTD	<i>Malus domestica</i>	stem segment	Diffuse porous	4.01
Paudel <i>et al.</i> 2013	TTD	<i>Peltophorum dubium</i>	stem segment	Diffuse porous	3.70
Paudel <i>et al.</i> 2013	TTD	<i>Prunus persica</i>	stem segment	Diffuse porous	4.00
Peters <i>et al.</i> 2017	TD	<i>Larix decidua</i>	stem segment	Tracheids	16.50
Peters <i>et al.</i> 2017	TD	<i>Picea abies</i>	stem segment	Tracheids	15.90
Prendergast <i>et al.</i> 2007	T-max	<i>Actinidia chinensis</i>	stem segment	Diffuse porous	9.50
Shackel <i>et al.</i> 1992	SHB	<i>Prunus persica</i>	whole plant	Diffuse porous	6.25
Smith <i>et al.</i> 1995	CHP	<i>Acacia holosericea</i>	stem segment	Diffuse porous	NA
Smith <i>et al.</i> 1995	CHP	<i>Acacia holosericea</i>	without roots	Diffuse porous	NA
Smith <i>et al.</i> 1995	CHP	<i>Acacia nilotica</i>	stem segment	Diffuse porous	NA
Smith <i>et al.</i> 1995	CHP	<i>Azadirachta indica</i>	stem segment	Diffuse porous	NA
Smith <i>et al.</i> 1995	CHP	<i>Azadirachta indica</i>	without roots	Diffuse porous	NA
Sperling <i>et al.</i> 2012	TD	<i>Phoenix dactylifera</i>	whole plant	Monocot	60.00
Steppe <i>et al.</i> 2010	CHP	<i>Fagus grandifolia</i>	stem segment	Diffuse porous	18.00
Steppe <i>et al.</i> 2010	HFD	<i>Fagus grandifolia</i>	stem segment	Diffuse porous	18.12
Steppe <i>et al.</i> 2010	TD	<i>Fagus grandifolia</i>	stem segment	Diffuse porous	18.00

A.2. Tables A

Table A.1: Summary table of the studies used in the analyses presented in the paper. Sap flow method, species, calibration material, porosity and average stem/tree diameter are reported. (*continued*)

Study	Method	Species	Calibration material	Wood porosity	Diameter (cm)
Sun <i>et al.</i> 2012	TD	<i>Liquidambar styraciflua</i>	without roots	Diffuse porous	7.50
Sun <i>et al.</i> 2012	TD	<i>Pinus echinata</i>	without roots	Tracheids	7.50
Sun <i>et al.</i> 2012	TD	<i>Pinus taeda</i>	without roots	Tracheids	7.50
Sun <i>et al.</i> 2012	TD	<i>Populus deltoides</i>	without roots	Diffuse porous	7.50
Sun <i>et al.</i> 2012	TD	<i>Quercus alba</i>	without roots	Ring porous	7.50
Sun <i>et al.</i> 2012	TD	<i>Ulmus americana</i>	without roots	Ring porous	7.50
Swanson and Whitfield 1981	CHP	<i>Nothofagus solandri</i>	whole plant	Diffuse porous	11.00
Swanson and Whitfield 1981	CHP	<i>Pinus radiata</i>	whole plant	Tracheids	5.00
Urban <i>et al.</i> 2012	SHB	<i>Humulus lupulus</i>	without roots	Ring porous	NA
Vellame <i>et al.</i> 2010	SHB	<i>Citrus sinensis</i>	whole plant	Diffuse porous	1.40

Table A.2: Anova summary of the LMM models, using the same structure as objective 1, comparing calibrations reported in SFD and SF units (Units) for CHP and TD. CM (Calibration material).

Method	Calibration metric	Variable	Sum sq	Mean Sq	NumDF	DenDF	F.value	Pr(>F)
CHP	Ln-Ratio	Units	0.09	0.09	1	52.05	1.09	0.302
		CM	0.20	0.10	2	44.43	1.24	0.299
	Slope	Units	0.07	0.07	1	25.27	0.37	0.55
		CM	0.24	0.12	2	40.07	0.59	0.558
	Slope (ln-ln)	Units	0.00	0.00	1	12.35	0.02	0.89
		CM	0.14	0.07	2	22.13	0.91	0.416
	Z-Cor	Units	1.07	1.07	1	20.77	4.30	0.051 .
		CM	4.63	2.32	2	34.98	9.28	0.001 ***
TD	Ln-Ratio	Units	0.05	0.05	1	26.72	0.41	0.529
		CM	0.14	0.07	2	16.64	0.58	0.571
	Slope	Units	0.16	0.16	1	44.72	2.28	0.138
		CM	0.17	0.08	2	14.84	1.17	0.338
	Slope (ln-ln)	Units	0.22	0.22	1	72.67	2.18	0.144
		CM	0.14	0.07	2	29.27	0.71	0.501
	Z-Cor	Units	0.08	0.08	1	26.07	0.28	0.598
		CM	0.02	0.01	2	17.41	0.03	0.969

A.2. Tables A

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Table A.3: Summary of the LMM models of Ln-Ratio (accuracy), Slope (proportional bias), Slope (ln-ln) (linearity) and Z-Cor (precision) as a function of Methods and Calibration material (CM; Whole plant: whole plant on a container or lysimeter; No-roots: whole plant without roots). CHP is the reference level for the variable Method and Stem segment is the reference level for CM, corresponding to the model intercept. All other coefficient estimates indicate the difference relative to the intercept. σ^2 is the within-groups random variability (residuals of the model). τ_{00} is the between-group random variability. N is the number of levels within random groups. ICC is the Intraclass Correlation Coefficients of each random group. R^2m and R^2c are the variability explained by the fixed and the random factors, respectively.

Coefficients	Estimate	Conf. Int.	p-value									
Fixed effects												
(Intercept)	0.19	-0.052 , 0.425	0.129	0.96	0.779 , 1.135	<0.001	0.85	0.719 , 0.976	<0.001	2.32	1.982 , 2.653	2.32
Method (T-max)	-0.19	-0.611 , 0.240	0.395	-0.27	-0.584 , 0.038	0.089	-0.08	-0.312 , 0.142	0.463	-0.08	-0.669 , 0.506	-0.08
Method (HR)	-0.28	-0.510 , -0.047	0.019	-0.04	-0.247 , 0.162	0.683	0.06	-0.106 , 0.221	0.488	0.16	-0.205 , 0.525	0.16
Method (HFD)	-0.21	-0.409 , -0.003	0.048	0.01	-0.167 , 0.193	0.886	0.00	-0.143 , 0.143	1	0.54	0.220 , 0.862	0.54
Method (SHB)	-0.37	-0.843 , 0.095	0.124	-0.04	-0.365 , 0.285	0.809	0.18	-0.058 , 0.427	0.139	0.45	-0.170 , 1.070	0.45
Method (TD)	-0.65	-0.847 , -0.457	<0.001	-0.20	-0.368 , -0.041	0.015	0.28	0.160 , 0.406	<0.001	-0.12	-0.423 , 0.173	-0.12
Method (TTD)	-0.62	-0.941 , -0.310	<0.001	-0.22	-0.503 , 0.066	0.134	0.20	-0.016 , 0.421	0.072	-0.37	-0.877 , 0.133	-0.37
CM (Whole plant)	-0.03	-0.300 , 0.245	0.841	-0.13	-0.317 , 0.064	0.197	-0.14	-0.276 , -0.003	0.05	-0.67	-1.034 , -0.301	-0.67
CM (No-roots)	-0.13	-0.394 , 0.128	0.319	-0.08	-0.298 , 0.135	0.463	-0.06	-0.213 , 0.104	0.503	-0.78	-1.172 , -0.379	-0.78
Random effects												
σ^2		0.091			0.1			0.076			0.278	
τ_{00} Species		0.013			0.004			0.013			0.04	
τ_{00} Study		0.159			0.041			0.004			0.184	
$N_{Species}$		65			65			65			65	
N_{Study}		48			48			48			48	
ICC _{Species}		0.049			0.029			0.137			0.08	
ICC _{Study}		0.604			0.284			0.048			0.366	
Observations		290			290			290			290	

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B

Appendix Chapter 3

B.1 Figures B

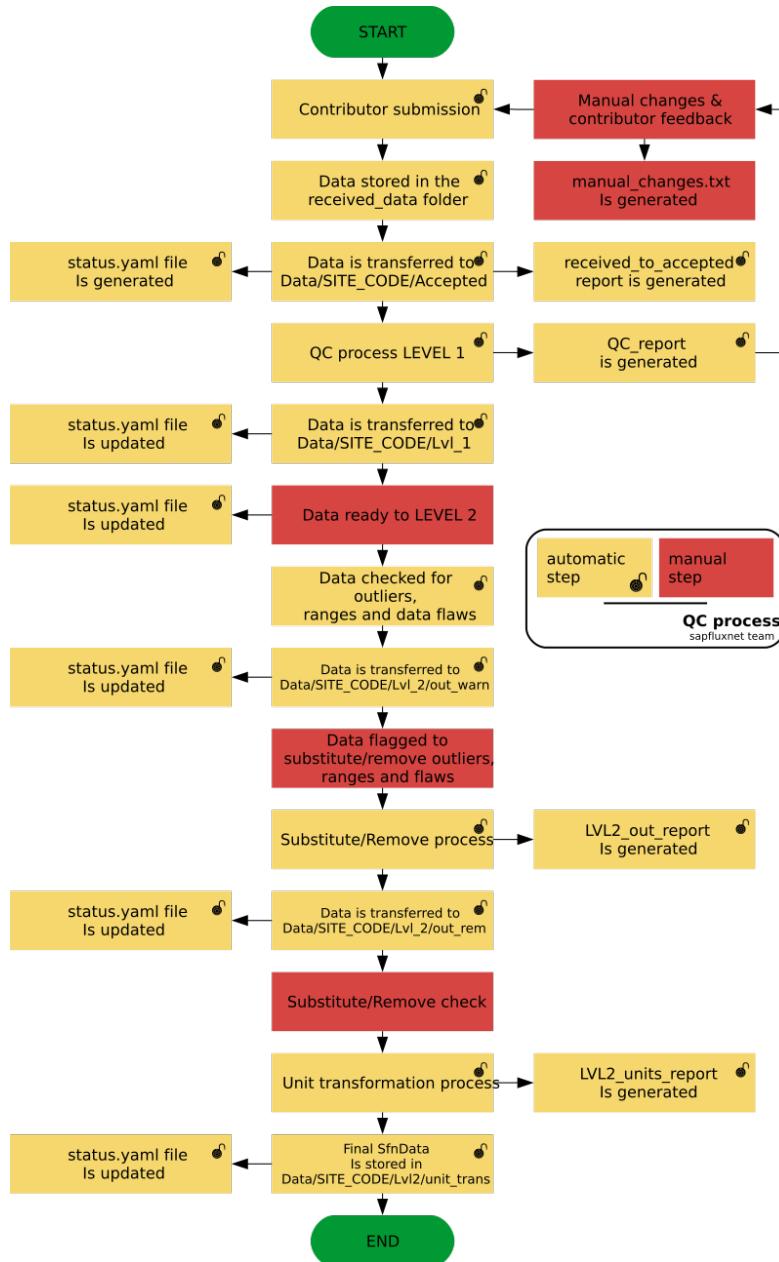


Figure B.1: Overview of the data QC process, showing file management and identifying automatic (in yellow) and manual steps (in red). The column on the left shows the different updates of the status file for each dataset and the column on the right shows generated data reports and steps requiring feedback or manual changes.

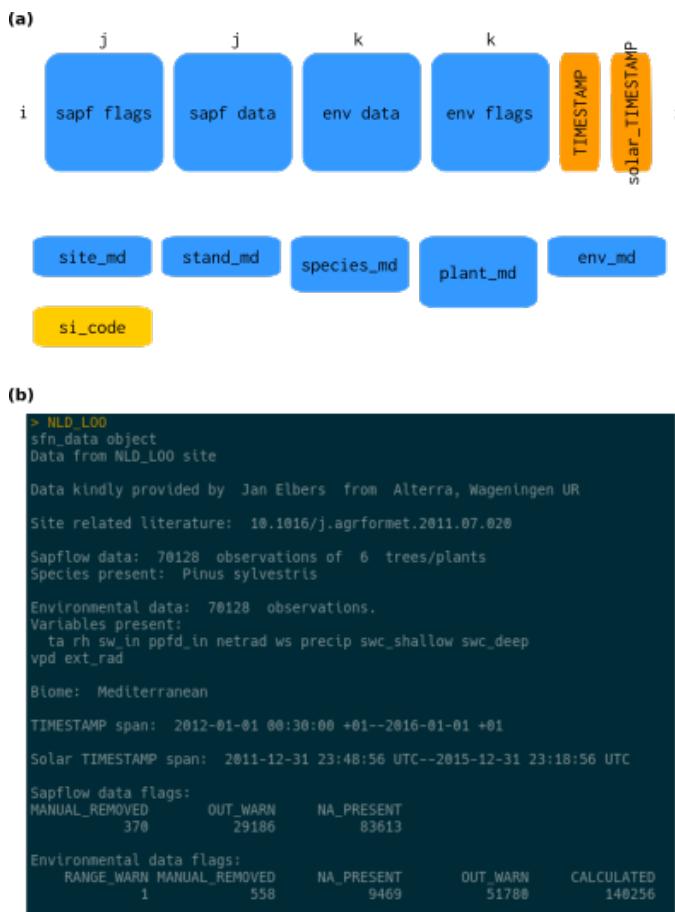


Figure B.2: (a) Structure of sfn_data objects, which are based on the S4 class. Boxes in the figure represent different slots where data are stored. Each object is identified by the ‘si_code’, stored as a slot in the object, with the format of a character vector. Slots storing time series of data and the associated data flags are of class ‘tibble’ and have all the same number of rows (i), corresponding to the the number of timesteps in the dataset and labelled with two POSIXct timestamp vectors TIMESTAMP, solar_TIMESTAMP).The slot storing sap flow data, ‘sapf_data’ contains(j) columns and environmental data (‘env_data’) contains k columns, corresponding to the number of environmental variables present. Slots with the suffix ‘md’ refer to the different metadata and all are objects of class ‘tibble’ with different dimensions. For example, the number of rows in plant_md depends on the number of plants in the dataset (and this is depicted by the different length of the box). More information on the ‘sfn_data’ class objects can be found in the vignette ‘sfn-data-classes’ of the package *sapfluxnetr* (Granda et al. 2020). (b) Summary of an sfn_data object, showing highlights of site metadata, data dimensions, timestamp span and flags present on the data.

B.1. Figures B

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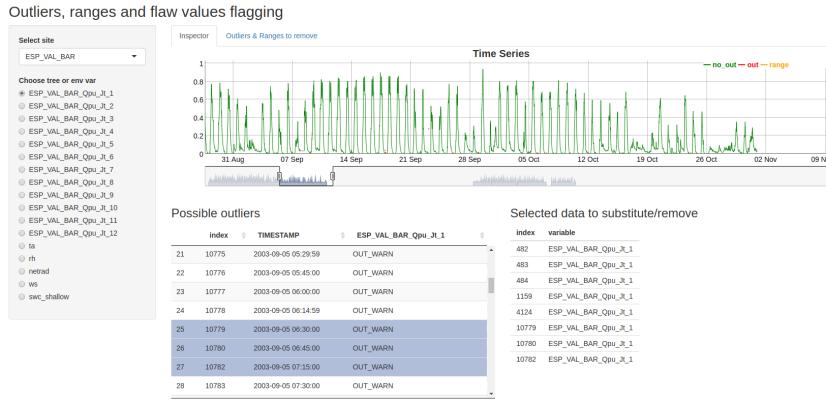


Figure B.3: Example screenshot of the app used for handling outliers and out of range values in time series. The left column shows dataset and variable selection. The central part shows the time series, with out of range values in red and possible outliers in yellow. Rows to replace or remove are selected in a table and written to a text file when done.

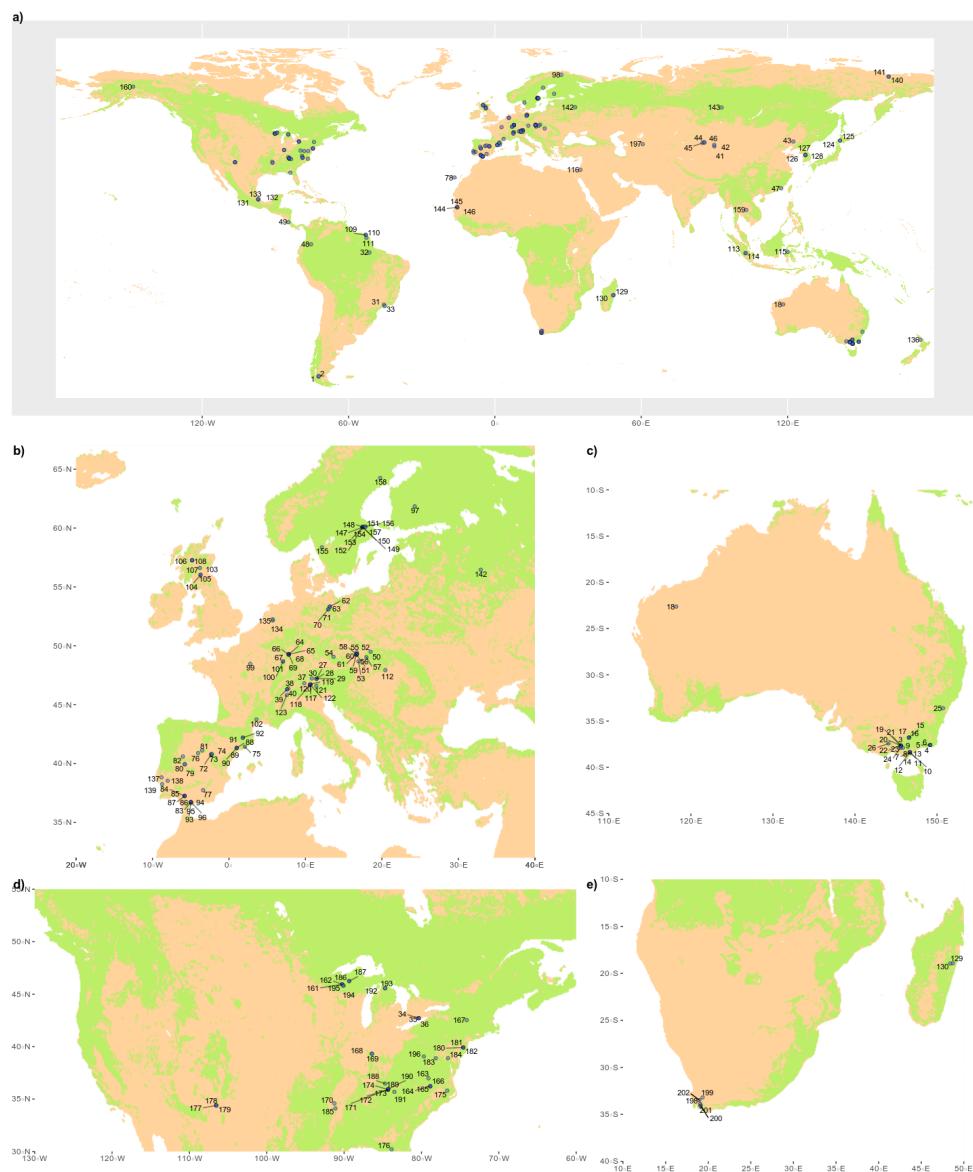
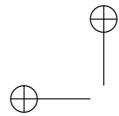
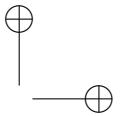
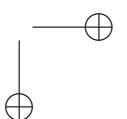
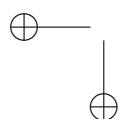


Figure B.4: Detailed geographic distribution of SAPFLUXNET datasets. Datasets are labelled by dataset number in Table S4. Woodland area from Crowther et al. (2015) shown in green.



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B.2 Tables B

Table B.1: Data checks implemented in the first level of data quality control (QC1).

Check	Description
Metadata variables	All metadata variables are checked for presence and expected class (numeric, character, logical...).
Character variables values	All metadata character variables are checked against the possible values (factor levels) for that variable, raising a warning if some value is out of the expected.
E-mail check	E-mail provided by contributors is checked for validity
Coordinates and biome	Site coordinates are checked for correctness (are they inside the specified country?) and fixed if needed and possible. MAT and MAP values are obtained for that coordinates and the biome is calculated from that values.
Soil texture	Percentages of soil textures are used to calculate the USDA classification category if possible.
Species names	Species names in plant and species metadata are checked for spelling errors and the concordance between both metadata is also checked
Plant treatments	Check for uniformity in the treatment declared by plant.
Environmental variables presence	Check for concordance between the declared variables in the environmental metadata and the environmental data.
Timestamp	Format, NA presence (there is data, but there is no timestamp), concordance and continuity are checked.
Gap presence:	Data gaps (There is TIMESTAMP but there is no data) are summarised and visualized.
Soil water content	Check for percentage swc values and transform them to cm ³ /cm ³

B.2. Tables B**Table B.2: Description of site metadata variables.**

Variable	Description	Type	Units
si_name	Site name given by contributors	Character	None
si_country	Country code (ISO)	Character	Fixed values
si_contact_firstname	Contributor first name	Character	None
si_contact_lastname	Contributor last name	Character	None
si_contact_email	Contributor email	Character	None
si_contact_institution	Contributor affiliation	Character	None
si_addcontr_firstname	Additional contributor first name	Character	None
si_addcontr_lastname	Additional contributor last name	Character	None
si_addcontr_email	Additional contributor email	Character	None
si_addcontr_institution	Additional contributor affiliation	Character	None
si_lat	Site latitude (i.e. 42.36)	Numeric	Latitude, decimal format (WGS84)
si_long	Site longitude (i.e. -8.23)	Numeric	Longitude, decimal format (WGS84)
si_elev	Elevation above sea level	Numeric	meters
si_paper	Paper with relevant information to understand the site as DOI links or DOI codes	Character	DOI link
si_dist_mgmt	Recent and historic disturbance and management events that affected the measurement years	Character	Fixed values
si_igbp	Vegetation type based on IGBP classification	Character	Fixed values
si_flux_network	Logical indicating if site is participating in the FLUXNET network	Logical	Fixed values
si_dendro_network	Logical indicating if site is participating in the DENDROGLOBAL network	Logical	Fixed values
si_remarks	Remarks and commentaries useful to grasp some site-specific peculiarities	Character	None
si_code	sapfluxnet site code, unique for each site	Character	Fixed value
si_mat	Site annual mean temperature, as obtained from WorldClim	Numeric	Celsius degrees
si_map	Site annual mean precipitation, as obtained from WorldClim	Numeric	mm
si_biome	Biome classification as per Whittaker diagram, based on mat and map obtained from WorldClim	Character	sapfluxnet calculated

Table B.3: Description of site metadata variables.

Variable	Description	Type	Units
st_name	Stand name given by contributors	Character	None
st_growth_condition	Growth condition with respect to stand origin and management	Character	Fixed values
st_treatment	Treatment applied at stand level	Character	None
st_age	Mean stand age at the moment of sap flow measurements	Numeric	years
st_height	Canopy height	Numeric	meters
st_density	Total stem density for stand	Numeric	stems ha ⁻¹
st_basal_area	Total stand basal area	Numeric	m ² ha ⁻¹
st_lai	Total maximum stand leaf area (one-sided, projected)	Numeric	m ² m ⁻²
st_aspect	Aspect the stand is facing (exposure)	Character	Fixed values
st_terrain	Slope and/or relief of the stand	Character	Fixed values
st_soil_depth	Soil total depth	Numeric	cm
st_soil_texture	Soil texture class, based on simplified USDA classification	Character	Fixed values
st_sand_perc	Soil sand content, % mass	Numeric	% percentage
st_silt_perc	Soil silt content, % mass	Numeric	% percentage
st_clay_perc	Soil clay content, % mass	Numeric	% percentage
st_remarks	Remarks and commentaries useful to grasp some stand-specific peculiarities	Character	None
st_USDA_soil_texture	USDA soil classification based on the percentages provided by the contributor	Character	sapfluxnet calculated

B.2. Tables B

Table B.4: Description of species metadata variables.

Variable	Description	Type	Units
sp_name	Identity of each measured species	Character	Scientific name without author abbreviation, as accepted by The Plant List
sp_ntrees	Number of trees measured of each species	Numeric	number of trees
sp_leaf_habit	Leaf habit of the measured species	Character	Fixed values
sp_basal_area_perc	Basal area occupied by each measured species, in percentage over total stand basal area	Numeric	% percentage

Table B.5: Description of plant metadata variables.

Variable	Description	Type	Units
pl_name	Plant code assigned by contributors	Character	None
pl_species	Species identity of the measured plant	Character	Scientific name without author abbreviation, as accepted by The Plant List
pl_treatment	Experimental treatment (if any)	Character	None
pl_dbh	Diameter at breast height of measured plants	Numeric	cm
pl_height	Height of measured plants	Numeric	m
pl_age	Plant age at the moment of measure	Numeric	years
pl_social	Plant social status	Character	Fixed values
pl_sapw_area	Cross-sectional sapwood area	Numeric	cm ²
pl_sapw_depth	Sapwood depth, measured at breast height	Numeric	cm
pl_bark_thick	Plant bark thickness	Numeric	mm
pl_leaf_area	Leaf area of each measured plant	Numeric	m ²
pl_sens_meth	Sap flow measures method	Character	Fixed values
pl_sens_man	Sap flow measures sensor manufacturer	Character	Fixed values
pl_sens_cor_grad	Correction for natural temperature gradients method	Character	Fixed values
pl_sens_cor_zero	Zero flow determination method	Character	Fixed values
pl_sens_calib	Was species-specific calibration used?	Logical	Fixed values
pl_sap_units	Uniformized sapfluxnet units for sapwood, leaf and plant level	Character	Fixed values
pl_sap_units_orig	Original contribution units (at sapwood or plant level)	Character	Fixed values
pl_sens_length	Length of the needles or electrodes forming the sensor	Numeric	mm
pl_sens_hgt	Sensor installation height, measured from the ground	Numeric	m
pl_sens_timestep	Subdaily time step of sensor measures	Numeric	minutes
pl_radial_int		Character	Fixed values
pl_azimut_int		Character	Fixed values
pl_remarks	Remarks and commentaries useful to grasp some plant-specific peculiarities	Character	None
pl_code	sapfluxnet plant code, unique for each plant	Character	Fixed value

Table B.6: Description of environmental metadata variables.

Variable	Description	Type	Units
env_time_zone	Time zone of site used in the TIMESTAMPS	Character	Fixed values
env_time_daylight	Is daylight saving time applied to the original timestamp?	Logical	Fixed values
env_timestep	Subdaily timestep of environmental measures	Numeric	minutes
env_ta	Location of air temperature sensor	Character	Fixed values
env_rh	Location of relative humidity sensor	Character	Fixed values
env_vpd	Location of relative vapour pressure deficit sensor	Character	Fixed values
env_sw_in	Location of shortwave incoming radiation sensor	Character	Fixed values
env_ppfd_in	Location of incoming photosynthetic photon flux density sensor	Character	Fixed values
env_netrad	Location of net radiation sensor	Character	Fixed values
env_ws	Location of wind speed sensor	Character	Fixed values
env_precip	Location of precipitation sensor	Character	Fixed values
env_swc_shallow_depth	Average depth for shallow soil water content measures	Numeric	cm
env_swc_deep_depth	Average depth for deep soil water content measures	Numeric	cm
env_plant_watpot	Availability of water potential values for the same measured plants during the sap flow measurements period	Character	Fixed values
env_leafarea_seasonal	Availability of seasonal course leaf area data and level	Character	Fixed values
env_remarks	Remarks and commentaries useful to grasp some environmental-specific peculiarities	Character	None

Table B.7: Data checks implemented in the second level of data quality control (QC2).

Data check	Description
Sap flow units harmonisation	Sap flow expressed in $\text{cm}^3 \text{ h}^{-1}$, sap flow per unit leafsapwood area in $\text{cm}^3 \text{ cm}^{-2} \text{ h}^{-1}$
Out of range detection	Out of range values are flagged automatically, examined in a visual app and removed if confirmed
Outlier detection	Outliers are flagged automatically, examined in a visual app and removed if confirmed
Radiation transformations	Interconversion between global radiation (sw_in) and photosynthetically active radiation (ppfd_in)
VPD and relative humidity	Interconversion between VPD and relative humidity
Extraterrestrial radiation and solar timestamp	Calculation of extraterrestrial radiation and solar timestamp from timestamp and geographical data
Sap flow interconversions	When sapwood or leaf areas were available, interconversions were applied between the different expression levels for sap flow (per plant, per sapwood area or per leaf area)

Table B.8: Datasets in the SAPFLUXNET database identified by numeric code, dataset code and site name. Number of species per dataset, geographic coordinates and elevation are also shown. Negative coordinate values are shown for Southern and Western Hemispheres.

si_code	si_name	si_lat	si_long	si_elev	# species
ARG_MAZ	Mazaruca_Patagonia	-51.58	-72.29	550	1
ARG_TRE	Tres Marias	-51.32	-72.19	460	1
AUS_BRI_BRI	Britannia Creek	-37.87	145.85	707	1
AUS_CAN_ST1_EUC	Cann River	-37.58	149.17	180	1
AUS_CAN_ST2_MIX	Cann River	-37.58	149.17	180	2
AUS_CAN_ST3 ACA	Cann River	-37.58	149.17	180	1
AUS_CAR THI_00F	Carrajung	-38.38	146.68	610	1
AUS_CAR THI_0P0	Carrajung	-38.38	146.68	610	1
AUS_CAR THI_0PF	Carrajung	-38.38	146.68	610	1
AUS_CAR THI_CON	Carrajung	-38.38	146.68	610	1
AUS_CAR THI_T00	Carrajung	-38.38	146.68	610	1
AUS_CAR THI_T0F	Carrajung	-38.38	146.68	610	1
AUS_CAR THI_TPO	Carrajung	-38.38	146.68	610	1
AUS_CAR THI_TPF	Carrajung	-38.38	146.68	610	1
AUS_ELL_HB_HIG	Ella	-36.78	146.58	705	2
AUS_ELL_MB_MOD	Ella	-36.78	146.58	693	1
AUS_ELL_UNB	Ella	-36.78	146.58	737	1
AUS_KAR	Karijini NP	-22.62	118.22	710	1
AUS_MAR_HSD_HIG	Maroondah	-37.64	145.58	468	2
AUS_MAR_HSW_HIG	Maroondah	-37.65	145.57	297	2
AUS_MAR_MSD_MOD	Maroondah	-37.64	145.58	467	2
AUS_MAR_MSW_MOD	Maroondah	-37.65	145.57	261	2
AUS_MAR_UBD	Maroondah	-37.69	145.56	303	3
AUS_MAR_UBW	Maroondah	-37.89	145.57	336	3
AUS_RIC_EUC_ELE	Richmond NSW EucFACE	-33.62	150.74	23	1
AUS_WOM	WombatStateForest	-37.42	144.09	705	2
AUT_PAT_FOR	Patscherkofel	47.21	11.45	1950	1
AUT_PAT_KRU	Patscherkofel	47.21	11.45	2180	1
AUT_PAT_TRE	Patscherkofel	47.21	11.45	2110	1
AUT_TSC	Tschirgant south	47.23	10.84	750	1
BRA_CAM	Campos do Jordão	-22.69	-45.52	2000	1
BRA_CAX_CON	Caxiuana	-1.79	-51.43	15	8
BRA_SAN	Santa Virgínia (PESM)	-23.28	-45.18	1000	4
CAN_TUR_P39_POS	TUR	42.71	-80.36	184	1
CAN_TUR_P39_PRE	TUR	42.71	-80.36	184	1
CAN_TUR_P74	TUR	42.71	-80.35	184	1
CHE_DAV_SEE	Davos	46.82	9.86	1650	1
CHE_LOT_NOR	Lotschental	46.39	7.76	1300	2
CHE_PFY_CON	Pfynwald	46.30	7.60	615	1
CHE_PFYIRR	Pfynwald	46.30	7.60	615	1
CHN_ARG_GWD	Arghan	40.75	89.99	830	1
CHN_ARG_GWS	Arghan	41.38	89.94	830	1

B.2. Tables B

Table B.8: Datasets in the SAPFLUXNET database identified by numeric code, dataset code and site name. Number of species per dataset, geographic coordinates and elevation are also shown. Negative coordinate values are shown for Southern and Western Hemispheres. (*continued*)

si_code	si_name	si_lat	si_long	si_elev	# species
CHN_HOR_AFF	Horqin	42.72	122.37	226	1
CHN_YIN_ST1	Yingbazar	42.45	85.72	900	1
CHN_YIN_ST2_DRO	Yingbazar	42.11	85.13	930	1
CHN_YIN_ST3_DRO	Yingbazar	42.29	85.99	930	1
CHN_YUN_YUN	Yunxiao	23.92	117.42	0	2
COL_MAC_SAF_RAD	Macagual Universidad de la Amazonia	1.50	-75.36	360	1
CRI_TAM_TOW	TAMU Soltis Center	10.39	-84.63	600	17
CZE_BIK	Bik	49.49	18.53	875	1
CZE_BIL_BIL	Bilovice	49.25	16.69	320	1
CZE_KRT_KRT	Krtiny	49.32	16.75	480	1
CZE_LAN	Lanžhot	48.68	16.95	150	3
CZE_LIZ_LES	Liz	49.07	13.68	858	1
CZE_RAJ_RAJ	Rajec	49.44	16.70	600	1
CZE_SOB_SOB	Sobesice	49.25	16.69	320	1
CZE_STI	Stitna nad Vlari	49.04	17.97	550	1
CZE_UTE_BEE	Utechov	49.28	16.65	420	1
CZE_UTE_BNA	Utechov	49.28	16.65	390	1
CZE_UTE_BPO	Utechov	49.28	16.65	370	1
CZE_UTE_SPR	Utechov	49.28	16.65	360	1
DEU_HIN_OAK	Hinnensee	53.33	13.19	90	1
DEU_HIN_TER	Hinnensee	53.33	13.19	95	2
DEU_MER_BEE_NON	Merzalben	49.27	7.81	550	1
DEU_MER_BEE THI	Merzalben	49.27	7.81	550	1
DEU_MER_DOU_NON	Merzalben	49.27	7.81	550	1
DEU_MER_DOU THI	Merzalben	49.27	7.81	550	1
DEU_MER_MIX_NON	Merzalben	49.27	7.81	550	2
DEU_MER_MIX THI	Merzalben	49.27	7.81	550	2
DEU_STE_2P3	Stechlin	53.10	13.00	78	1
DEU_STE_4P5	Stechlin	53.10	13.00	78	1
ESP_ALT_ARM	Alto Tajo	40.78	-2.33	1079	3
ESP_ALT_HUE	Alto Tajo	40.79	-2.29	907	2
ESP_ALT_TRI	Alto Tajo	40.80	-2.23	981	2
ESP_CAN	Can Balasc	41.43	2.07	270	4
ESP_GUA_VAL	Guadarrama	40.90	-4.03	1140	1
ESP_LAH_COM	LaHarina	37.74	-3.38	180	1
ESP_LAS	Las Canadas, Teide natinal park tenerife	28.31	-16.57	2070	1
ESP_MAJ_MAI	Majadas del Tietar	39.94	-5.77	260	1
ESP_MAJ_NOR_LM1	Majadas del Tietar	39.94	-5.77	260	1
ESP_MON_SIE_NAT	Montejo	41.12	-3.50	1400	3
ESP_RIN	Rinconada experimental catchment	40.60	-6.02	1200	1

Table B.8: Datasets in the SAPFLUXNET database identified by numeric code, dataset code and site name. Number of species per dataset, geographic coordinates and elevation are also shown. Negative coordinate values are shown for Southern and Western Hemispheres. (*continued*)

si_code	si_name	si_lat	si_long	si_elev	# species
ESP_RON_PIL	Ronda	36.69	-5.02	1734	2
ESP_SAN_A2_45I	Sanabria orchard	37.25	-5.80	49	1
ESP_SAN_A_45I	Sanabria orchard	37.25	-5.80	49	1
ESP_SAN_B_100	Sanabria orchard	37.25	-5.80	49	1
ESP_SAN_B2_100	Sanabria orchard	37.25	-5.80	49	1
ESP_TIL_MIX	Tillar	41.33	1.01	1018	2
ESP_TIL_OAK	Tillar	41.33	1.01	1011	1
ESP_TIL_PIN	Tillar	41.33	1.01	1065	1
ESP_VAL_BAR	Vallcebre	42.20	1.82	1102	1
ESP_VAL_SOR	Vallcebre	42.20	1.81	1257	1
ESP_YUN_C1	Yunquera	36.72	-4.97	1220	1
ESP_YUN_C2	Yunquera	36.72	-4.97	1180	1
ESP_YUN_T1 THI	Yunquera	36.72	-4.97	1190	1
ESP_YUN_T3 THI	Yunquera	36.72	-4.97	1185	1
FIN_HYY_SME	Hyytiala Forest Field Station	61.85	24.29	185	2
FIN_PET	Petsikko	69.49	27.23	251	1
FRA_FON	Fontainebleau-Barbeau	48.48	2.78	105	2
FRA_HES_HE1_NON	Hesse	48.67	7.06	300	1
FRA_HES_HE2_NON	Hesse	48.67	7.06	300	1
FRA_PUE	Puechabon	43.74	3.60	270	1
GBR_ABE_PLO	Aberfeldy	56.62	-3.80	340	1
GBR_DEV_CON	Devilla	56.03	-3.72	75	1
GBR_DEV_DRO	Devilla	56.03	-3.72	75	1
GBR_GUI_ST1	Guisachan	57.27	-4.82	300	1
GBR_GUI_ST2	Guisachan	57.27	-4.82	300	1
GBR_GUI_ST3	Guisachan	57.27	-4.82	300	1
GUF_GUY_GUY	Guyaflux	5.28	-52.92	40	6
GUF_GUY_ST2	Guyaflux	5.28	-52.91	45	7
GUF_NOU_PET	Nouragues station	4.08	-52.68	120	10
HUN_SIK	Sikfokut	47.93	20.44	330	2
IDN_JAM_OIL	Jambi	-2.07	102.79	71	1
IDN_JAM_RUB	Jambi	-2.10	102.78	90	1
IDN_PON_STE	Pono	-1.49	120.06	1050	8
ISR_YAT_YAT	Yatir	31.34	35.05	650	1
ITA_FEI_S17	Feichtwald-Matsch	46.69	10.61	1715	1
ITA_KAE_S20	Kaelbergangl-Matsch	46.70	10.61	1990	1
ITA_MAT_S21	Matscher Alm-Matsch	46.74	10.69	2100	2
ITA_MUN	Muntatschinig-Matsch	46.68	10.58	1160	1
ITA_REN	Renon	46.59	11.43	1794	3
ITA_RUN_N20	Runer Koepfl-Matsch	46.70	10.64	2030	2
ITA_TOR	Torgnon	45.82	7.56	2100	1

B.2. Tables B

Table B.8: Datasets in the SAPFLUXNET database identified by numeric code, dataset code and site name. Number of species per dataset, geographic coordinates and elevation are also shown. Negative coordinate values are shown for Southern and Western Hemispheres. (*continued*)

si_code	si_name	si_lat	si_long	si_elev	# species
JPN_EBE_HYB	Ebetsu	43.08	141.52	40	1
JPN_EBE_SUG	Ebetsu	43.08	141.52	40	1
KOR_TAE_TC1_LOW	Taehwa	37.30	127.32	160	1
KOR_TAE_TC2_MED	Taehwa	37.30	127.32	160	1
KOR_TAE_TC3_EXT	Taehwa	37.30	127.32	160	1
MDG_SEM_TAL	Semi-mature forest	-18.93	48.71	950	6
MDG_YOU_SHO	Young secondary forest	-18.95	48.40	990	1
MEX_COR_YP	Cortadura	19.49	-97.04	2180	1
MEX_VER_BSJ	VERACRUZ_BSJ	19.51	-96.98	1440	5
MEX_VER_BSM	VERACRUZ_BSM	19.53	-96.99	1524	2
NLD_LOO	Loobos	52.17	5.74	25	1
NLD_SPE_DOU	Speulderbos	52.25	5.69	50	1
NZL_HUA_HUA	Huapai	-36.80	174.49	90	1
PRT_LEZ_ARN	LEZIRIAS	38.83	-8.82	15	1
PRT_MIT	MITRA II	38.54	-8.00	235	1
PRT_PIN	Pinheiro da Cruz	38.25	-8.76	5	2
RUS_CHE_LOW	Cherskii	68.74	161.50	90	1
RUS_CHE_Y4	CHE	68.74	161.41	6	1
RUS_FYO	Fyodorovskoye	56.46	32.92	260	3
RUS_POG_VAR	Pogorelsky Bor	56.36	92.95	243	3
SEN_SOUP_IRR	Souilène	16.34	-15.43	10	1
SEN_SOUP_POS	Souilène	16.34	-15.43	10	1
SEN_SOUP_PRE	Souilène	16.34	-15.43	10	1
SWE_NOR_ST1_AF1	Norunda	60.09	17.48	45	2
SWE_NOR_ST1_AF2	Norunda	60.09	17.48	45	2
SWE_NOR_ST1_BEF	Norunda	60.09	17.48	45	2
SWE_NOR_ST2	Norunda	60.09	17.48	45	2
SWE_NOR_ST3	Norunda	60.09	17.48	45	2
SWE_NOR_ST4_AFT	Norunda	60.08	17.48	45	3
SWE_NOR_ST4_BEF	Norunda	60.08	17.48	45	2
SWE_NOR_ST5_REF	Norunda	60.08	17.48	45	3
SWE_SKO_MIN	Skogaryd	58.36	12.15	76	1
SWE_SKY_38Y	Skyttorp	60.13	17.84	50	1
SWE_SKY_68Y	Skyttorp	60.10	17.83	50	2
SWE_SVA_MIX_NON	Svartberget	64.26	19.77	267	2
THA_KHU	Khu-Muang	15.27	103.08	150	1
USA_BNZ_BLA	BNZSPRC1	64.70	-148.32	50	1
USA_CHE_ASP	ChEAS	45.94	-90.27	477	6
USA_CHE_MAP	ChEAS	45.95	-90.26	1565	2
USA_DUK_HAR	Duke Blackwood Hardwood	36.98	-79.09	163	6
USA_HIL_HF1_POS	Hill Demonstration Forest	36.22	-78.86	174	5

Table B.8: Datasets in the SAPFLUXNET database identified by numeric code, dataset code and site name. Number of species per dataset, geographic coordinates and elevation are also shown. Negative coordinate values are shown for Southern and Western Hemispheres. (*continued*)

si_code	si_name	si_lat	si_long	si_elev	# species
USA_HIL_HF1_PRE	Hill Demonstration Forest	36.22	-78.86	174	5
USA_HIL_HF2	Hill Demonstration Forest	36.22	-78.86	174	7
USA_HUY_LIN_NON	Huyck Preserve Lincoln Pond	42.53	-74.16		1
USA_INM	INMMSF	39.32	-86.41	286	6
USA_MOR_SF	Morgan-Monroe State Forest	39.32	-86.41	275	4
USA_NWH	NWhiteRiver	34.58	-91.26	48	2
USA_ORN_ST1_AMB	ORNL-FACE	35.90	-84.33	227	1
USA_ORN_ST2_AMB	ORNL-FACE	35.90	-84.33	227	1
USA_ORN_ST3_ELE	ORNL-FACE	35.90	-84.33	227	1
USA_ORN_ST4_ELE	ORNL-FACE	35.90	-84.33	227	1
USA_PAR_FER	Parker Tract	35.80	-76.67	5	1
USA_PER_PER	Perry	30.21	-83.87	14	1
USA_PJS_P04_AMB	PJSEV -Rainfall	34.39	-106.53	1911	2
Manipulation Experiment - Sevilleta NWR, USA					
USA_PJS_P08_AMB	PJSEV -Rainfall	34.39	-106.53	1911	2
Manipulation Experiment - Sevilleta NWR, USA					
USA_PJS_P12_AMB	PJSEV -Rainfall	34.39	-106.53	1911	2
Manipulation Experiment - Sevilleta NWR, USA					
USA_SIL_OAK_1PR	Silas Little Experimental Forest premortality	39.92	-74.60	33	4
USA_SIL_OAK_2PR	Silas Little Experimental Forest premortality	39.92	-74.60	33	4
USA_SIL_OAK_POS	Silas Little Experimental Forest premortality	39.92	-74.60	33	5
USA_SMI_SCB	Smithsonian Conservation Biology Institute	38.89	-78.15	273	3
USA_SMI_SER	Smithsonian Environmental Research Center	38.89	-76.56	19	5
USA_SWH	SWhiteRiver	34.11	-91.13	44	2
USA_SYL_HL1	Sylvania Wilderness	46.24	-89.35	500	3
USA_SYL_HL2	Sylvania Wilderness	46.24	-89.35	500	4
USA_TNB	TNBSF	36.47	-84.70	454	4
USA_TNO	TNOAK	35.97	-84.28	340	5
USA_TNP	TNPINE	35.96	-84.29	342	5
USA_TNY	TNYPOP	35.69	-83.50	850	3
USA_UMB_CON	UMBS	45.56	-84.71	236	5

Table B.8: Datasets in the SAPFLUXNET database identified by numeric code, dataset code and site name. Number of species per dataset, geographic coordinates and elevation are also shown. Negative coordinate values are shown for Southern and Western Hemispheres. (*continued*)

si_code	si_name	si_lat	si_long	si_elev	# species
USA_UMB_GIR	UMB	45.56	-84.70	239	4
USA_WIL_WC1	Willow Creek	45.81	-90.09	520	5
USA_WIL_WC2	Willow Creek	45.81	-90.09	520	4
USA_WWF	WVFEF	39.06	-79.69	844	5
UZB_YAN_DIS	Yangibazar	41.65	60.62	101	2
ZAF_FRA_FRA	Franshoek South Africa	-33.88	19.06	190	1
ZAF_NOO_E3_IRR	Nooitgedacht farm	-33.20	19.34	1089	1
ZAF_RAD	Radyn EGVV	-34.08	19.11	409	1
ZAF_SOU_SOU	Southfield EGVV	-34.09	19.09	389	1
ZAF_WEL_SOR	Wellington Western Cape	-33.48	18.96	81	1

Table B.9: Number of plants and number of datasets for each species present in the SAPFLUXNET database.

Species	# trees	# sites	Species	# trees	# sites	Species	# trees	# sites
<i>Pinus sylvestris</i>	290	28	<i>Acacia tortilis</i>	9	3	<i>Prunus serotina</i>	3	2
<i>Picea abies</i>	178	19	<i>Quercus spp.</i>	9	2	<i>Populus canescens</i>	3	1
<i>Acer saccharum</i>	162	9	<i>Kandelia obovata</i>	8	1	<i>Eucalyptus camaldulensis</i>	3	1
<i>Fagus sylvatica</i>	116	16	<i>Carpinus betulus</i>	8	2	<i>Qualea rosea</i>	3	1
<i>Pinus taeda</i>	107	6	<i>Castanopsis acuminatissima</i>	8	1	<i>Licania alba</i>	3	1
<i>Populus tremuloides</i>	104	1	<i>Pinus patula</i>	8	1	<i>Eucalyptus dives</i>	2	1
<i>Pinus koraiensis</i>	96	3	<i>Eucalyptus radiata</i>	7	5	<i>Licania octandra</i>	2	1
<i>Eucalyptus nitens</i>	89	8	<i>Betula pubescens</i> subsp. <i>czerepanovii</i>	7	1	<i>Swartzia racemosa</i>	2	1
<i>Pinus strobus</i>	75	5	<i>Avicennia marina</i>	6	1	<i>Manilkara bidentata</i>	2	1
<i>Liquidambar styraciflua</i>	69	10	<i>Quercus robur</i>	6	1	<i>Licania membranacea</i>	2	2
<i>Quercus ilex</i>	62	6	<i>Fraxinus excelsior</i>	6	1	<i>Eschweilera grandiflora</i>	2	1
<i>Acer rubrum</i>	62	12	<i>Cryptocarya laevigata</i>	6	1	<i>Pouteria viridis</i>	2	1
<i>Liriodendron tulipifera</i>	51	11	<i>Myrtaceae fam.</i>	6	1	<i>Ampelocera macrocarpa</i>	2	1
<i>Fagus grandifolia</i>	48	4	<i>Palaquium luzoniense</i>	6	1	<i>Otoba novogranatensis</i>	2	1
<i>Pinus resinosa</i>	43	1	<i>Platea excelsa</i>	6	1	<i>Mortoniiodendron anisophyllum</i>	2	1
<i>Eucalyptus globulus</i>	35	2	<i>Pouteria firma</i>	6	1	<i>Meliosma idiopoda</i>	2	1
<i>Larix decidua</i>	34	8	<i>Agathis australis</i>	6	1	<i>Taxus baccata</i>	2	1
<i>Abies pinsapo</i>	34	5	<i>Ostrya virginiana</i>	6	3	<i>Sloanea sp.</i>	2	2
<i>Acacia mearnsii</i>	33	2	<i>Picea mariana</i>	6	1	<i>Betula sp.</i>	2	1
<i>Quercus pyrenaica</i>	32	2	<i>Nothofagus pumilio</i>	5	1	<i>Picea glauca</i>	2	1
<i>Quercus rubra</i>	32	6	<i>Nothofagus cunninghamii</i>	5	1	<i>Fraxinus americana</i>	2	1
<i>Quercus petraea</i>	31	5	<i>Eucalyptus cypellocarpa</i>	5	4	<i>Carya cordiformis</i>	2	1

B.2. Tables B

Table B.9: Number of plants and number of datasets for each species present in the SAPFLUXNET database. (continued)

Species	# trees	# sites	Species	# trees	# sites	Species	# trees	# sites
<i>Pseudotsuga menziesii</i>	29	5	<i>Eucalyptus rubida</i>	5	1	<i>Quercus prinus</i>	2	1
<i>Pinus halepensis</i>	27	2	<i>Drimys brasiliensis</i>	5	1	<i>Elaeagnus angustifolia</i>	2	1
<i>Quercus velutina</i>	24	4	<i>Alchornea triplinervia</i>	5	1	<i>Qualea tricolor</i>	2	1
<i>Tsuga canadensis</i>	24	2	<i>Santiria apiculata</i>	5	1	<i>Lecythis poiteaui</i>	2	1
<i>Larix cajanderi</i>	23	2	<i>Quercus michauxii</i>	5	1	<i>Quercus cerris</i>	2	1
<i>Betula papyrifera</i>	21	2	<i>Quercus phellos</i>	5	1	<i>Pleuranthodendron lindenii</i>	1	1
<i>Quercus montana</i>	21	3	<i>Pinus rigida</i>	5	3	<i>Inga sp.</i>	1	1
<i>Quercus pubescens</i>	19	2	<i>Tilia americana</i>	5	2	<i>Cupania macrophylla</i>	1	1
<i>Abies balsamea</i>	19	1	<i>Nothofagus antarctica</i>	4	1	<i>Genipa americana</i>	1	1
<i>Quercus alba</i>	19	7	<i>Eucalyptus baxteri</i>	4	2	<i>Brosimum alicastrum</i>	1	1
<i>Pinus cembra</i>	18	6	<i>Coprosma quadrifida</i>	4	2	<i>Pouteria sp.</i>	1	1
<i>Populus euphratica</i>	16	6	<i>Eschweilera coriacea</i>	4	2	<i>Macrolobium costaricense</i>	1	1
<i>Olea europaea</i>	16	5	<i>Arbutus unedo</i>	4	1	<i>Eschweilera sp.</i>	1	1
<i>Quercus rotundifolia</i>	16	3	<i>Psiadia altissima</i>	4	1	<i>Aspidosperma desmanthum</i>	1	1
<i>Hevea brasiliensis</i>	16	2	<i>Quercus suber</i>	4	1	<i>Trophis mexicana</i>	1	1
<i>Betula alleghaniensis</i>	16	2	<i>Betula pubescens</i>	4	2	<i>Betula pendula</i>	1	1
<i>Pinus nigra</i>	15	3	<i>Fraxinus pennsylvanica</i>	4	2	<i>Iryanthera sagotiana</i>	1	1
<i>Picea sitchensis</i>	15	1	<i>Pouteria anomala</i>	3	1	<i>Vantanea sp</i>	1	1
<i>Pinus edulis</i>	15	3	<i>Protium tenuifolium</i>	3	1	<i>Recordoxylon speciosum</i>	1	1
<i>Juniperus monosperma</i>	15	3	<i>Hieronyma alchorneoides</i>	3	1	<i>Larix kaempferi x Larix gmelini</i>	1	1
<i>Eucalyptus victrix</i>	14	1	<i>Mollinedia schottiana</i>	3	1	<i>Cryptomeria japonica</i>	1	1
<i>Eucalyptus obliqua</i>	14	5	<i>Rustia formosa</i>	3	1	<i>Eugenia spp.</i>	1	1
<i>Quercus lyrata</i>	13	2	<i>Theobroma cacao</i>	3	1	<i>Ocotea samosa</i>	1	1
<i>Celtis laevigata</i>	13	2	<i>Carapa guianensis</i>	3	1	<i>Leptolaena sp.</i>	1	1

Table B.9: Number of plants and number of datasets for each species present in the SAPFLUXNET database. (*continued*)

Species	# trees	# sites	Species	# trees	# sites	Species	# trees	# sites
<i>Quercus coccinea</i>	13	4	<i>Gymnanthes riparia</i>	3	1	<i>Abrahamia ditimena</i>	1	1
<i>Populus grandidentata</i>	12	1	<i>Ilex aquifolium</i>	3	1	<i>Brachylaena ramiflora</i>	1	1
<i>Malus domestica</i>	11	3	<i>Vouacapoua americana</i>	3	3	<i>Cryptocarya sp.</i>	1	1
<i>Eucalyptus tereticornis</i>	10	1	<i>Oxandra asbeckii</i>	3	2	<i>Saurauia pedunculata</i>	1	1
<i>Quercus faginea</i>	10	2	<i>Gouania glabra</i>	3	3	<i>Turpinia insignis</i>	1	1
<i>Pinus canariensis</i>	10	1	<i>Vernonia arborea</i>	3	1	<i>Sassafras albidum</i>	1	1
<i>Elaeis guineensis</i>	10	1	<i>Platanus mexicana</i>	3	1	<i>Ulmus americana</i>	1	1
<i>Acacia longifolia</i>	10	1	<i>Clethra macrophylla</i>	3	2	<i>Carya glabra</i>	1	1
<i>Pinus pinaster</i>	10	1	<i>Larix sibirica</i>	3	1	<i>Quercus falcata</i>	1	1
<i>Thuja occidentalis</i>	10	1	<i>Larix gmelinii</i>	3	1	<i>Cornus florida</i>	1	1
<i>Carya tomentosa</i>	10	2	<i>Pinus sibirica</i>	3	1	<i>Licania rodriquesii</i>	1	1
<i>Dicorynia guianensis</i>	9	2	<i>Pinus virginiana</i>	3	1	<i>Sextonia rubra</i>	1	1

B.2. Tables B

Table B.10: Number of plants per genus present in the SAPFLUXNET database.

Genus	# trees	Genus	# trees	Genus	# trees
<i>Pinus</i>	725	<i>Cryptocarya</i>	7	<i>Ampelocera</i>	2
<i>Quercus</i>	326	<i>Avicennia</i>	6	<i>Otoba</i>	2
<i>Acer</i>	224	<i>Myrtaceae fam.</i>	6	<i>Mortoniodendron</i>	2
<i>Picea</i>	201	<i>Palaquium</i>	6	<i>Meliosma</i>	2
<i>Eucalyptus</i>	188	<i>Platea</i>	6	<i>Taxus</i>	2
<i>Fagus</i>	164	<i>Agathis</i>	6	<i>Sloanea</i>	2
<i>Populus</i>	135	<i>Ostrya</i>	6	<i>Elaeagnus</i>	2
<i>Liquidambar</i>	69	<i>Drimys</i>	5	<i>Lecythis</i>	2
<i>Larix</i>	64	<i>Alchornea</i>	5	<i>Pleuranthodendron</i>	1
<i>Abies</i>	53	<i>Santiria</i>	5	<i>Inga</i>	1
<i>Acacia</i>	52	<i>Tilia</i>	5	<i>Cupania</i>	1
<i>Betula</i>	51	<i>Qualea</i>	5	<i>Genipa</i>	1
<i>Liriodendron</i>	51	<i>Coprosma</i>	4	<i>Brosimum</i>	1
<i>Pseudotsuga</i>	29	<i>Arbutus</i>	4	<i>Macrolobium</i>	1
<i>Tsuga</i>	24	<i>Psiadia</i>	4	<i>Aspidosperma</i>	1
<i>Olea</i>	16	<i>Protium</i>	3	<i>Trophis</i>	1
<i>Hevea</i>	16	<i>Hieronyma</i>	3	<i>Iryanthera</i>	1
<i>Juniperus</i>	15	<i>Mollinedia</i>	3	<i>Vantanea</i>	1
<i>Nothofagus</i>	14	<i>Rustia</i>	3	<i>Recordoxylon</i>	1
<i>Carya</i>	13	<i>Theobroma</i>	3	<i>Cryptomeria</i>	1
<i>Celtis</i>	13	<i>Carapa</i>	3	<i>Eugenia</i>	1
<i>Pouteria</i>	12	<i>Gymnanthes</i>	3	<i>Ocotea</i>	1
<i>Fraxinus</i>	12	<i>Ilex</i>	3	<i>Leptolaena</i>	1
<i>Malus</i>	11	<i>Vouacapoua</i>	3	<i>Abrahamia</i>	1
<i>Elaeis</i>	10	<i>Oxandra</i>	3	<i>Brachylaena</i>	1
<i>Thuja</i>	10	<i>Gouphia</i>	3	<i>Saurauia</i>	1
<i>Dicorynia</i>	9	<i>Vernonia</i>	3	<i>Turpinia</i>	1
<i>Licania</i>	8	<i>Platanus</i>	3	<i>Sassafras</i>	1
<i>Kandelia</i>	8	<i>Clethra</i>	3	<i>Ulmus</i>	1
<i>Carpinus</i>	8	<i>Prunus</i>	3	<i>Cornus</i>	1
<i>Castanopsis</i>	8	<i>Swartzia</i>	2	<i>Sextonia</i>	1
<i>Eschweilera</i>	7	<i>Manilkara</i>	2		

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C

Appendix Chapter 4

C.1 Figures C

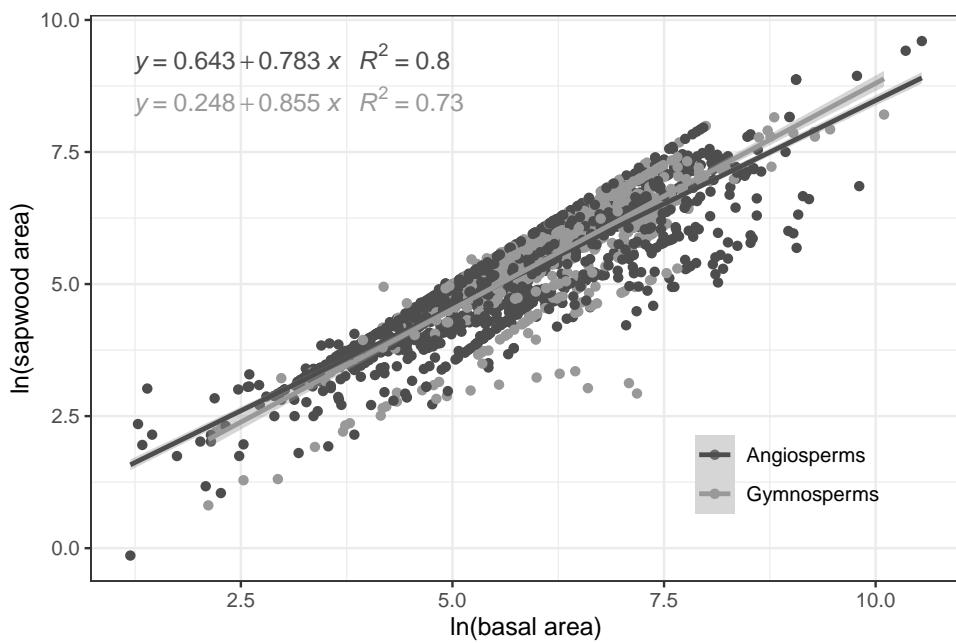


Figure C.1: SAPFLUXNET global scaling relationship between basal area and sapwood area. Shaded areas are 95% model confidence interval.

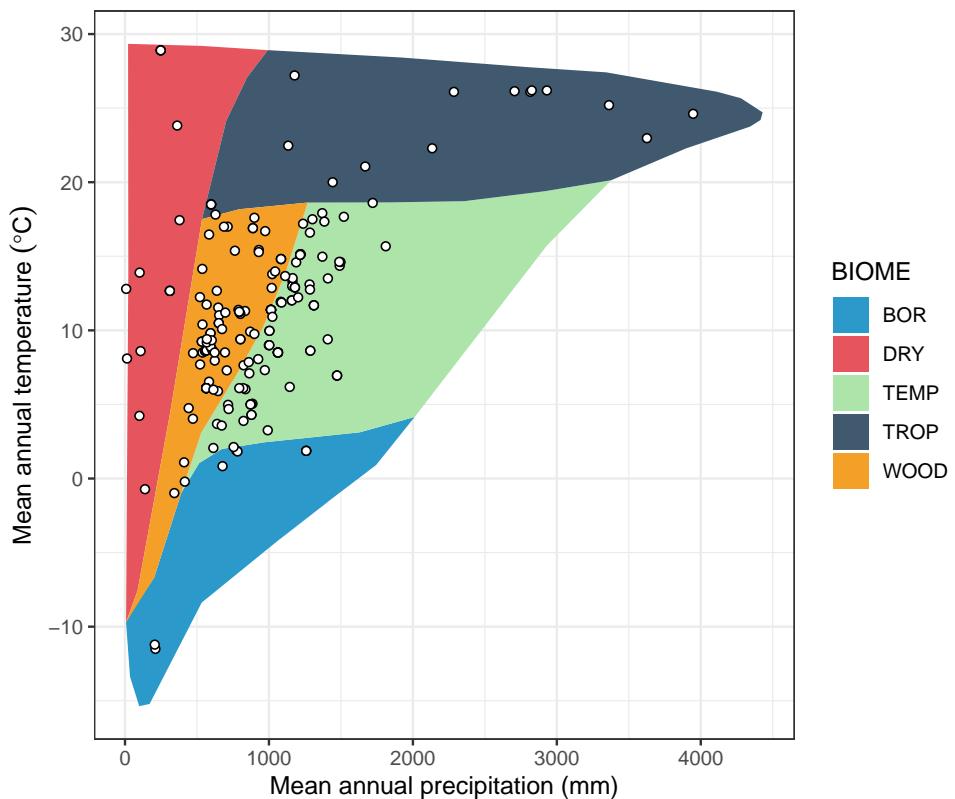


Figure C.2: Bioclimatic distribution of the SAPFLUXNET datasets used in the study. Points show the different datasets in a Whittaker diagram showing the classification of the aggregated biomes used in the study.

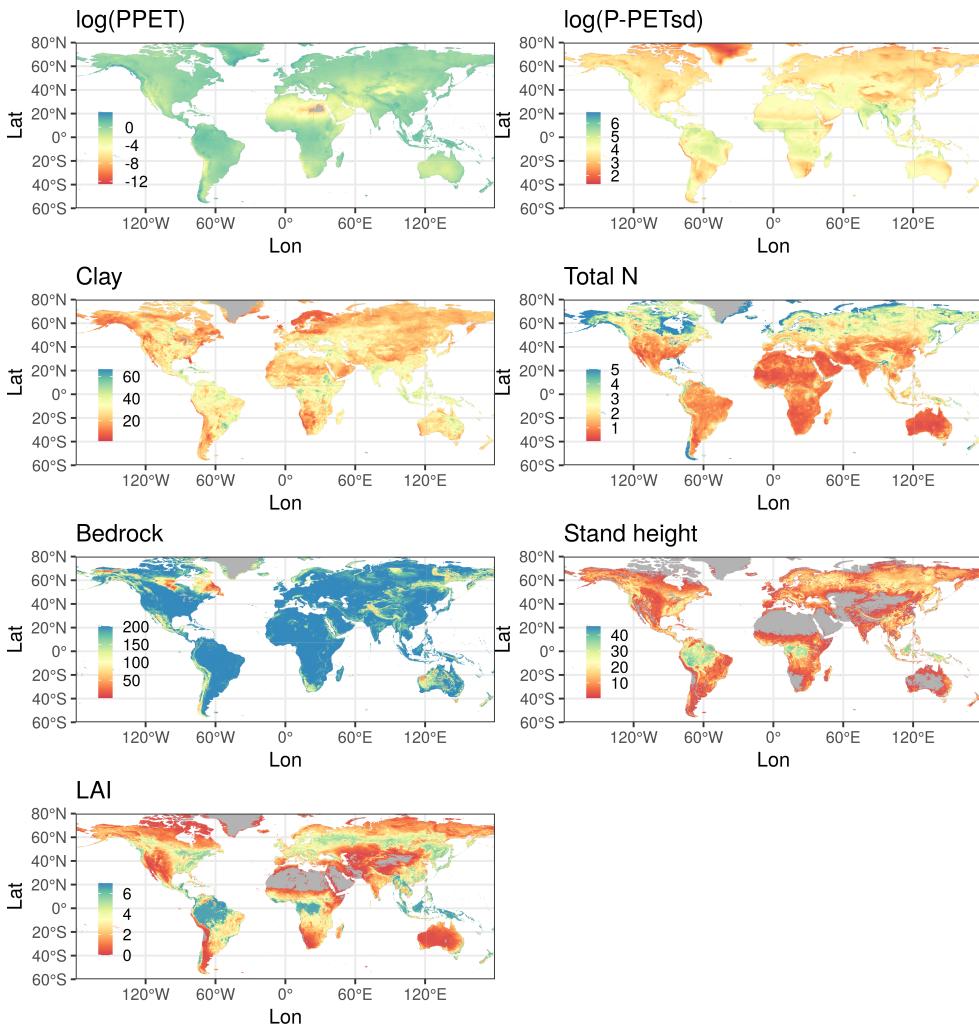


Figure C.3: Global projection of climatic, soil and stand structure variables. log(PPET): logarithm of precipitation over potential evapotranspiration [$\log(\text{mm } \text{mm}^{-1})$]; log($P - PET_{sd}$): logarithm of the standard deviation of the difference between precipitation and potential evapotranspiration [$\log(\text{mm})$]; Clay: percentage of clay in the soil; Total N: total nitrogen in the soil [$\text{g } \text{kg}^{-1}$]; Bedrock [cm]; Stand height [m]; LAI: leaf area index [$\text{m}^2 \text{ m}^{-2}$]. Total N values above $5 \text{ g } \text{kg}^{-1}$ were truncated.

C.1. Figures C

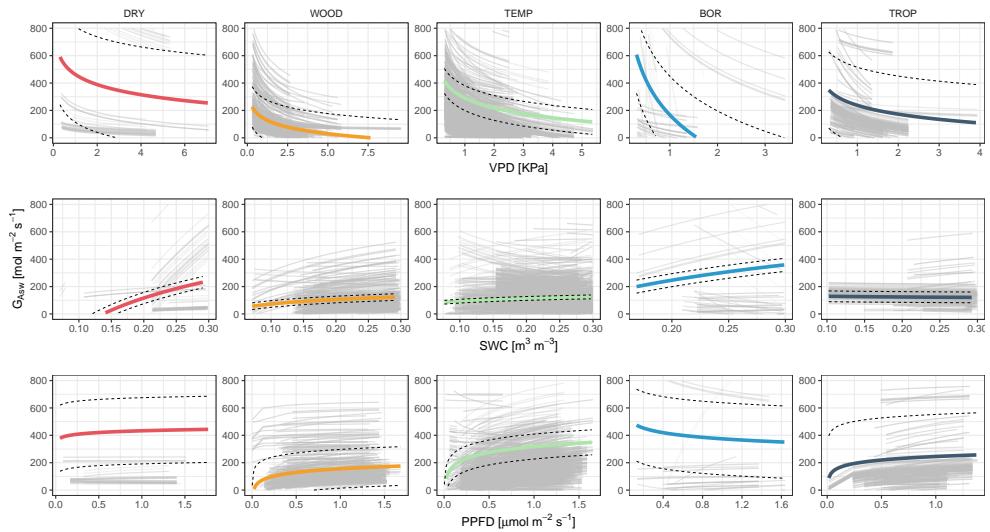


Figure C.4: Log relationships of the three environmental variables estimated with the TOTAL model ($\text{VPD} + \text{SWC} + \text{PPFD}$) and grouped by biome. Coloured lines are biome average models calculated from the Log-linear models predictions using LMM with G_s as response variable and the neperian logarithm of the environmental constrains as explanatory variables. Dashed line shows standard error of the average models calculated with bootstrap prediction using 100 simulations.

C.2 Tables C

Table C.1: SAPFLUXNET sites included in the study. Biome was calculated using Whittaker diagram. *Indicates that the biome was manually adjusted and confirmed by SAPFLUXNET contributors.

Site code	Latitude	Longitude	Biome	# Tree-days	# Species	# Trees
AUS_CAN_ST1_EUC	-37.58	149.17	WOOD	337	1	12
AUS_CAN_ST2_MIX	-37.58	149.17	WOOD	712	2	22
AUS_CAN_ST3 ACA	-37.58	149.17	WOOD	409	1	12
AUS_CAR THI CON	-38.38	146.68	TEMP	54	1	7
AUS_ELL_UNB	-36.78	146.58	TEMP	105	1	2
AUS_MAR_UBD	-37.69	145.56	TEMP	50	3	5
AUS_MAR_UBW	-37.89	145.57	TEMP	105	3	5
AUS_WOM	-37.42	144.09	TEMP	2130	2	11
AUT_PAT_FOR	47.21	11.45	BOR	149	1	3
AUT_PAT_KRU	47.21	11.45	BOR	70	1	3
AUT_PAT_TRE	47.21	11.45	BOR	81	1	3
BRA_CAM	-22.69	-45.52	TROP	79	1	5
BRA_CAX_CON	-1.79	-51.43	TROP	525	8	15
CAN_TUR_P39_PRE	42.71	-80.36	TEMP	1021	1	18
CAN_TUR_P74	42.71	-80.35	TEMP	1997	1	16
CHN_ARG_GWS	41.38	89.94	DRY	174	1	2
CHN_HOR_AFF	42.72	122.37	WOOD	1366	1	16
CHN_YIN_ST1	42.45	85.72	DRY	105	1	5
CRI_TAM_TOW	10.39	-84.63	TROP	666	17	26
CZE_BIL_BIL	49.25	16.69	TEMP	238	1	6
CZE_KRT_KRT	49.32	16.75	TEMP	238	1	6
CZE_LAN	48.68	16.95	TEMP	1093	3	17
CZE_RAJ_RAJ	49.44	16.70	TEMP	274	1	6
CZE_SOZ_SOZ	49.25	16.69	TEMP	655	1	6
CZE_STI	49.04	17.97	TEMP	263	1	8
CZE_UTE_BPO	49.28	16.65	TEMP	234	1	6
DEU_HIN_OAK	53.33	13.19	TEMP	482	1	8
DEU_HIN_TER	53.33	13.19	TEMP	1052	2	16
DEU_MER_BEE_NON	49.27	7.81	TEMP	495	1	8
DEU_MER_DOU_NON	49.27	7.81	TEMP	491	1	7
DEU_MER_MIX_NON	49.27	7.81	TEMP	1108	2	17
DEU_STE_2P3	53.10	13.00	TEMP	722	1	10
DEU_STE_4P5	53.10	13.00	TEMP	327	1	10
ESP_ALT_ARM	40.78	-2.33	WOOD	1990	3	15
ESP_ALT_HUE	40.79	-2.29	WOOD	967	2	8
ESP_ALT_TRI	40.80	-2.23	WOOD	1522	2	12
ESP_CAN	41.43	2.07	WOOD	2317	4	21
ESP_GUA_VAL	40.90	-4.03	WOOD	2100	1	24
ESP_LAS	28.31	-16.57	WOOD	1778	1	10
ESP_MAJ_MAI	39.94	-5.77	WOOD	978	1	6
ESP_MON_SIE_NAT	41.12	-3.50	WOOD	1250	3	20
ESP_RIN	40.60	-6.02	WOOD	502	1	8
ESP_RON_PIL	36.69	-5.02	TEMP	911	2	12
ESP_TIL_MIX	41.33	1.01	WOOD	3434	2	32
ESP_TIL_OAK	41.33	1.01	WOOD	717	1	10
ESP_TIL_PIN	41.33	1.01	WOOD	589	1	9

C.2. Tables C

Table C.1: SAPFLUXNET sites included in the study. Biome was calculated using Whittaker diagram. *Indicates that the biome was manually adjusted and confirmed by SAPFLUXNET contributors. (*continued*)

Site code	Latitude	Longitude	Biome	# Tree-days	# Species	# Trees
ESP_VAL_BAR	42.20	1.82	WOOD	837	1	12
ESP_VAL_SOR	42.20	1.81	WOOD	1109	1	13
ESP_YUN_C1	36.72	-4.97	WOOD	619	1	6
ESP_YUN_C2	36.72	-4.97	WOOD	288	1	6
FIN_HYY_SME	61.85	24.29	TEMP	34	2	4
FIN_PET	69.49	27.23	BOR	118	1	7
FRA_FON	48.48	2.78	TEMP	276	1	3
FRA_HES_HE1_NON	48.67	7.06	TEMP	620	1	10
FRA_HES_HE2_NON	48.67	7.06	TEMP	1347	1	10
FRA_PUE	43.74	3.60	WOOD	5229	1	25
GBR_ABE_PLO	56.62	-3.80	TEMP	486	1	15
GBR_DEV_CON	56.03	-3.72	TEMP	133	1	4
GBR_GUI_ST1	57.27	-4.82	TEMP	398	1	15
GBR_GUI_ST2	57.27	-4.82	TEMP	298	1	9
GBR_GUI_ST3	57.27	-4.82	TEMP	249	1	8
GUF_GUY_GUY	5.28	-52.92	TROP	246	6	6
GUF_GUY_ST2	5.28	-52.91	TROP	369	7	11
GUF_NOU_PET	4.08	-52.68	TROP	562	10	22
HUN_SI	47.93	20.44	WOOD	365	2	4
ISR_YAT_YAT	31.34	35.05	DRY	3704	1	24
ITA_FEI_S17	46.69	10.61	TEMP	244	1	6
ITA_KAE_S20	46.70	10.61	BOR	325	1	6
ITA_MUN	46.68	10.58	TEMP	384	1	6
ITA_REN	46.59	11.43	TEMP	247	3	8
ITA_RUN_N20	46.70	10.64	BOR	331	2	8
MEX_COR_YP	19.49	-97.04	TEMP	119	1	8
NLD_LOO	52.17	5.74	TEMP	621	1	6
NLD_SPE_DOU	52.25	5.69	TEMP	107	1	3
NZL_HUA_HUA	-36.80	174.49	TEMP	243	1	6
PRT_LEZ_ARN	38.83	-8.82	WOOD	403	1	4
PRT_MIT	38.54	-8.00	WOOD	494	1	4
PRT_PIN	38.25	-8.76	WOOD	1233	2	20
RUS_CHE_Y4	68.74	161.41	BOR	447	1	11
RUS_FYO	56.46	32.92	TEMP	1132	3	17
RUS_POG_VAR	56.36	92.95	TEMP	603	3	9
SEN_SOU_PRE	16.34	-15.43	DRY	466	1	3
SWE_NOR_ST1_BEF	60.09	17.48	TEMP	653	2	22
SWE_NOR_ST2	60.09	17.48	TEMP	175	2	12
SWE_NOR_ST3	60.09	17.48	TEMP	810	2	37
SWE_NOR_ST5_REF	60.08	17.48	TEMP	712	3	35
SWE_SKO_MIN	58.36	12.15	TEMP	533	1	11
SWE_SKY_38Y	60.13	17.84	TEMP	326	1	12
SWE_SKY_68Y	60.10	17.83	TEMP	664	2	12
SWE_SVA_MIX_NON	64.26	19.77	TEMP	861	2	20
THA_KHU	15.27	103.08	TROP	411	1	6
USA_BNZ_BLA	64.70	-148.32	BOR	797	1	6
USA_CHE_ASP	45.94	-90.27	TEMP	3548	6	149
USA_CHE_MAP	45.95	-90.26	TEMP	2651	2	153
USA_DUK_HAR	36.98	-79.09	TEMP	495	6	34

Table C.1: SAPFLUXNET sites included in the study. Biome was calculated using Whittaker diagram. *Indicates that the biome was manually adjusted and confirmed by SAPFLUXNET contributors. (*continued*)

Site code	Latitude	Longitude	Biome	# Tree-days	# Species	# Trees
USA_HIL_HF2	36.22	-78.86	TEMP	228	5	23
USA_INM	39.32	-86.41	TEMP	766	6	9
USA_MOR_SF	39.32	-86.41	TEMP	285	4	6
USA_NWH	34.58	-91.26	TEMP	248	2	10
USA_ORN_ST1_AMB	35.90	-84.33	TEMP	247	1	8
USA_PAR_FER	35.80	-76.67	TEMP	467	1	8
USA_PER_PER	30.21	-83.87	TROP	6269	1	80
USA_PJS_P04_AMB	34.39	-106.53	DRY	2313	2	10
USA_PJS_P08_AMB	34.39	-106.53	DRY	2262	2	10
USA_PJS_P12_AMB	34.39	-106.53	DRY	2350	2	10
USA_SIL_OAK_1PR	39.92	-74.60	TEMP	1210	4	18
USA_SIL_OAK_2PR	39.92	-74.60	TEMP	2275	4	22
USA_SMI_SER	38.89	-76.56	TEMP	1045	5	31
USA_SWH	34.11	-91.13	TEMP	511	2	16
USA_SYL_HL1	46.24	-89.35	TEMP	3130	3	48
USA_SYL_HL2	46.24	-89.35	TEMP	1631	4	20
USA_TNB	36.47	-84.70	TEMP	583	4	8
USA_TNO	35.97	-84.28	TEMP	680	5	9
USA_TNP	35.96	-84.29	TEMP	806	5	9
USA_UMB_CON	45.56	-84.71	TEMP	5840	5	57
USA_UMB_GIR	45.56	-84.70	TEMP	5867	4	57
USA_WIL_WC1	45.81	-90.09	TEMP	639	5	16
USA_WVF	39.06	-79.69	TEMP	488	5	8
ZAF_FRA_FRA	-33.88	19.06	WOOD	220	1	3
ZAF_RAD	-34.08	19.11	WOOD	303	1	3
ZAF_SOUL_SOUL	-34.09	19.09	WOOD	198	1	2
ZAF_WEL_SOR	-33.48	18.96	WOOD	356	1	3

Table C.2: SAPFLUXNET stand treatments included in the this study (Poyatos *et al.* 2020).

Plot treatment
None
Control
control
Ambient Control
Control - Unthinned
natural conditions
Reference
1Premortality
2premortality
distructive sampling
Girdling early successional
Pre-thinning
Before thinning
Before Thinning
non thinned
none (periodict thinning every 5-6 years 20 to 25% of basal area)
Radiation Level
AMBIENT CO2 FACE rings
fertilization at plantation
AcaciaMonoculture
MixtureEucalyptusAndAcacia
EucalyptusMonoculture
Pre Irrigation

Table C.3: Summary table of site level R^2_{VPD} , R^2_{SWC} , R^2_{PPFD} , climate, soil properties and vegetation structure data. PPET is in [mm mm⁻¹], P-PET_{sd} is in [mm], Clay and Sand are in [%], Total N is in [g kg⁻¹], Stand height is in [m], LAI is in [m²_{leaves} m²_{soil}]. Letters show data source: a = SAPFLUXNET, b = Global rasters, c = SAPFLUXNET plant height.

Site code	R^2_{vpd}	R^2_{swc}	R^2_{ppfd}	Relimp VPD	Relimp SWC	Relimp PPFD	PPET	P - PET _{sd}	Clay	Sand	Total N	Bedrock	Stand height	LAI
AUS_CAN_ST1_EUC	0.74	0.44	0.54	0.65	0.35	0.00	1.23	47.52	26.30 b	45.10 b	1.02	184	22.00 a	1.39 a
AUS_CAN_ST2_MIX	0.91	0.65	0.76	0.87	0.13	0.00	1.23	47.52	26.30 b	45.10 b	1.02	184	21.80 a	2.07 a
AUS_CAN_ST3 ACA	0.85	0.67	0.74	0.87	0.12	0.01	1.23	47.52	26.30 b	45.10 b	1.02	184	11.80 a	1.35 a
AUS_CAR THI CON	0.67	0.00	0.00	0.99	0.00	0.01	1.36	49.01	27.20 b	44.30 b	2.34	111	17.21 a	4.80 a
AUS_ELL_UNB	0.87	0.44	0.76	0.97	0.00	0.03	1.08	67.16	26.70 b	48.50 b	1.95	63	25.00 a	6.20 b
AUS_MAR_UBD	0.79	0.53	0.69	0.71	0.29	0.00	1.35	70.37	26.60 b	44.60 b	1.90	89	25.00 a	2.10 a
AUS_MAR_UBW	0.90	0.81	0.82	0.90	0.00	0.09	1.21	65.38	27.90 b	43.90 b	2.00	173	40.00 a	2.30 a
AUS_WOM	0.82	0.52	0.49	0.79	0.00	0.20	1.09	69.35	25.90 b	52.90 b	1.97	172	22.00 a	2.20 a
AUT_PAT_FOR	0.78	0.73	0.68	0.82	0.09	0.09	2.17	16.78	5.00 a	60.00 a	3.94	180	12.00 a	4.30 b
AUT_PAT_KRU	0.61	0.45	0.50	0.77	0.06	0.17	2.17	16.78	5.00 a	60.00 a	3.94	180	0.75 a	4.30 b
AUT_PAT_TRE	0.58	0.27	0.19	0.70	0.30	0.00	2.17	16.78	5.00 a	60.00 a	3.94	180	4.00 a	4.30 b
BRA_CAM	0.83	0.68	0.69	0.65	0.28	0.07	1.66	88.82	27.60 b	52.00 b	2.26	200	12.00 a	5.30 a
BRA_CAX_CON	0.79	0.74	0.73	0.70	0.00	0.30	1.90	122.90	8.00 a	79.00 a	1.45	197	38.00 b	5.30 a
CAN_TUR_P39_PRE	0.59	0.37	0.34	0.71	0.08	0.21	1.39	42.08	1.00 a	98.00 a	1.58	200	23.40 a	5.30 a
CAN_TUR_P74	0.26	0.47	0.14	0.32	0.38	0.30	1.39	41.87	1.00 a	98.00 a	1.60	200	16.20 a	6.70 a
CHN_ARG_GWS	0.42	0.32	0.27	0.51	0.47	0.01	0.01	63.51	17.70 b	46.00 b	0.70	172	7.90 a	0.36 a
CHN_HOR_AFF	0.39	0.38	0.34	0.25	0.75	0.00	0.59	31.24	8.00 a	83.00 a	1.00	200	9.05 a	1.61 a
CHN_YIN_ST1	0.47	0.45	0.44	0.63	0.18	0.20	0.19	35.09	20.80 b	32.90 b	2.41	148	10.60 a	0.50 b
CRI_TAM_TOW	0.73	0.73	0.73	0.46	0.11	0.44	3.57	159.99	36.10 b	34.70 b	2.75	200	30.60 a	3.30 a
CZE_BIL_BIL	0.54	0.50	0.41	0.57	0.20	0.23	0.71	28.98	29.60 b	27.40 b	1.91	200	14.00 a	6.00 b
CZE_KRT_KRT	0.57	0.45	0.30	0.58	0.03	0.39	0.85	27.00	26.00 b	27.40 b	2.10	200	17.00 a	5.70 b
CZE_LAN	0.79	0.76	0.72	0.67	0.08	0.25	0.66	37.49	17.80 a	71.80 a	2.46	200	36.00 a	6.04 a
CZE_RAJ_RAJ	0.38	0.40	0.43	0.33	0.07	0.60	0.99	26.14	21.80 b	33.90 b	1.96	200	18.00 a	4.60 b
CZE_SOZ_SOZ	0.48	0.45	0.14	0.52	0.25	0.23	0.71	28.98	29.60 b	27.40 b	1.91	200	21.00 a	6.00 b
CZE_STI	0.54	0.32	0.39	0.70	0.18	0.12	1.13	27.10	34.20 a	47.60 a	1.65	200	31.00 a	5.50 a
CZE_UTE_BPO	0.62	0.65	0.52	0.46	0.16	0.38	0.75	29.86	26.70 b	23.80 b	2.71	200	18.00 a	6.10 b
DEU_HIN_OAK	0.43	0.19	0.33	0.92	0.07	0.01	0.95	35.10	17.90 b	49.90 b	2.42	200	31.45 c	5.70 b
DEU_HIN_TER	0.31	0.22	0.24	0.76	0.01	0.24	0.95	35.10	18.00 b	50.50 b	2.05	200	24.43 c	5.60 b

C.2. Tables C

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Table C.3: Summary table of site level R^2_{VPD} , R^2_{SWC} , R^2_{PPFD} , climate, soil properties and vegetation structure data. PPET is in [mm mm⁻¹], P-PET_{sd} is in [mm], Clay and Sand are in [%], Total N is in [g kg⁻¹], Stand height is in [m], LAI is in [$m^2_{leaves} m^2_{soil}$]. Letters show data source: a = SAPFLUXNET, b = Global rasters, c = SAPFLUXNET plant height. (*continued*)

Site code	R^2_{VPD}	R^2_{SWC}	R^2_{PPFD}	Relimp VPD	Relimp SWC	Relimp PPFD	PPET	P - PET _{sd}	Clay	Sand	Total N	Bedrock	Stand height	LAI
DEU_MER_BEE_NON0.47	0.27	0.29	0.76	0.06	0.18	1.48	47.33	4.00 a	71.00 a	2.56	200	23.00 a	5.90 a	
DEU_MER_DOU_NON0.45	0.25	0.22	0.60	0.31	0.10	1.48	47.33	4.00 a	71.00 a	2.56	200	29.00 a	5.30 a	
DEU_MER_MIX_NON0.41	0.23	0.26	0.82	0.02	0.16	1.48	47.33	4.00 a	71.00 a	2.56	200	30.00 a	6.10 a	
DEU_STE_2P3	0.56	0.15	0.30	0.86	0.09	0.05	0.90	37.45	2.50 a	92.50 a	3.28	200	27.20 a	4.30 b
DEU_STE_4P5	0.48	0.27	0.31	0.64	0.28	0.09	0.90	37.45	2.50 a	92.50 a	3.28	200	27.20 a	4.30 b
ESP_ALT_ARM	0.51	0.30	0.29	0.91	0.01	0.09	0.66	65.80	21.90 b	41.50 b	1.27	187	19.00 b	1.09 a
ESP_ALT_HUE	0.47	0.22	0.18	0.78	0.02	0.21	0.51	63.08	21.60 b	35.90 b	1.46	200	8.64 c	1.50 b
ESP_ALT_TRI	0.58	0.44	0.31	0.80	0.07	0.12	0.57	63.48	21.00 b	40.00 b	1.31	196	4.89 a	1.60 b
ESP_CAN	0.55	0.40	0.34	0.74	0.02	0.24	0.94	46.91	32.90 b	28.30 b	1.76	179	10.80 a	3.30 a
ESP_GUA_VAL	0.51	0.28	0.23	0.69	0.00	0.31	0.68	69.09	24.80 b	40.90 b	1.27	200	12.00 a	3.80 a
ESP_LAS	0.37	0.25	0.07	0.57	0.37	0.06	1.63	37.89	1.00 a	70.00 a	1.65	197	10.30 a	3.60 a
ESP_MAJ_MAI	0.56	0.43	0.28	0.73	0.14	0.12	0.76	97.45	9.00 a	80.00 a	1.18	200	7.00 a	0.30 a
ESP_MON_SIE_NAT	0.25	0.20	0.22	0.49	0.09	0.42	0.62	63.05	20.80 b	41.90 b	1.45	200	22.00 a	3.30 b
ESP_RIN	0.83	0.61	0.59	0.97	0.00	0.03	0.85	76.30	15.00 a	9.00 a	2.17	200	7.40 a	3.40 a
ESP_RON_PIL	0.37	0.25	0.17	0.60	0.07	0.33	1.05	93.66	18.00 a	30.00 a	1.86	200	2.60 a	0.90 b
ESP_TIL_MIX	0.45	0.36	0.22	0.55	0.09	0.36	0.77	48.10	20.00 a	60.00 a	1.44	162	14.20 a	3.27 a
ESP_TIL_OAK	0.31	0.38	0.18	0.45	0.15	0.40	0.77	48.10	20.00 a	60.00 a	1.44	162	5.00 a	4.59 a
ESP_TIL_PIN	0.37	0.45	0.08	0.43	0.37	0.20	0.79	48.10	20.00 a	60.00 a	1.78	188	18.30 a	1.02 a
ESP_VAL_BAR	0.61	0.22	0.29	0.90	0.00	0.10	0.70	34.07	32.63 a	9.81 a	1.94	200	10.60 a	2.10 a
ESP_VAL_SOR	0.58	0.36	0.26	0.73	0.14	0.13	0.78	32.15	20.00 a	60.00 a	2.04	200	11.00 a	2.40 a
ESP_YUN_C1	0.37	0.50	0.24	0.28	0.56	0.16	0.83	93.65	29.00 a	22.00 a	1.37	197	10.60 a	2.20 b
ESP_YUN_C2	0.28	0.62	0.27	0.21	0.43	0.37	0.78	91.33	29.00 a	22.00 a	1.37	188	11.60 a	2.50 b
FIN_HYY_SME	0.57	0.49	0.62	0.12	0.86	0.02	1.20	38.32	6.50 a	37.00 a	1.67	200	18.00 a	1.30 a
FIN_PET	0.59	0.50	0.58	0.47	0.37	0.16	1.13	26.34	7.30 b	60.80 b	5.08	200	3.76 a	0.61 a
FRA_FON	0.78	0.68	0.68	0.70	0.17	0.13	0.89	45.10	19.00 a	37.00 a	1.26	200	28.00 a	6.00 a
FRA_HES_HE1_NON	0.46	0.57	0.41	0.45	0.25	0.30	1.31	47.72	25.00 a	8.00 a	1.41	200	12.80 a	6.00 a
FRA_HES_HE2_NON	0.33	0.50	0.16	0.42	0.27	0.31	1.31	47.72	25.00 a	8.00 a	1.41	200	13.00 a	6.00 a
FRA_PUE	0.49	0.52	0.33	0.51	0.18	0.30	1.27	70.16	39.00 a	26.00 a	1.69	195	5.00 a	2.40 a
GBR_ABE_PLO	0.40	0.37	0.35	0.51	0.22	0.27	1.92	47.48	10.00 a	60.00 a	3.70	179	10.00 a	6.00 a

Table C.3: Summary table of site level R^2_{VPD} , R^2_{SWC} , R^2_{PPFD} , climate, soil properties and vegetation structure data. PPET is in [mm mm⁻¹], P-PET_{sd} is in [mm], Clay and Sand are in [%], Total N is in [g kg⁻¹], Stand height is in [m], LAI is in [m²_{leaves} m²_{soil}]. Letters show data source: a = SAPFLUXNET, b = Global rasters, c = SAPFLUXNET plant height. (*continued*)

Site code	R^2_{VPD}	R^2_{SWC}	R^2_{PPFD}	Relimp VPD	Relimp SWC	Relimp PPFD	PPET	P - PET _{sd}	Clay	Sand	Total N	Bedrock	Stand height	LAI
GBR_DEV_CON	0.89	0.45	0.58	0.95	0.01	0.04	1.43	44.38	14.80 b	56.90 b	3.44	200	15.00 a	1.92 a
GBR_GUI_ST1	0.84	0.79	0.78	0.68	0.00	0.32	3.19	68.11	3.70 b	80.40 b	14.26	197	11.00 a	0.92 a
GBR_GUI_ST2	0.64	0.55	0.49	0.59	0.03	0.38	3.19	68.11	3.70 b	80.40 b	14.26	197	13.30 a	0.94 a
GBR_GUI_ST3	0.86	0.82	0.79	0.73	0.03	0.24	3.19	68.11	3.70 b	80.40 b	14.26	197	14.30 a	1.57 a
GUF_GUY_GUY	0.97	0.89	0.94	0.82	0.05	0.12	2.88	135.18	43.00 a	48.00 a	1.53	200	35.00 a	7.00 a
GUF_GUY_ST2	0.80	0.77	0.76	0.61	0.30	0.09	3.02	141.34	43.20 a	47.80 a	1.66	200	35.00 a	6.70 a
GUF_NOU_PET	0.76	0.53	0.66	1.00	0.00	0.00	2.69	158.16	59.20 a	33.20 a	2.22	200	35.00 a	5.50 a
HUN_SIK	0.86	0.42	0.56	0.90	0.00	0.09	0.70	39.64	30.40 b	44.00 b	1.64	200	20.00 a	7.00 a
ISR_YAT_YAT	0.40	0.32	0.18	0.62	0.37	0.01	0.28	83.43	28.00 a	31.00 a	0.71	178	11.00 a	1.70 a
ITA_FEI_S17	0.53	0.37	0.30	0.66	0.14	0.19	1.08	22.97	8.00 a	76.00 a	3.11	117	20.00 a	3.10 b
ITA_KAE_S20	0.68	0.45	0.46	0.75	0.07	0.18	1.24	22.97	17.00 a	50.00 a	3.64	121	14.00 a	2.60 b
ITA_MUN	0.63	0.48	0.42	0.62	0.31	0.06	0.80	29.87	7.00 a	55.00 a	1.93	188	18.00 a	2.20 b
ITA_REN	0.85	0.77	0.79	0.95	0.02	0.04	1.61	12.59	17.70 b	47.90 b	2.73	143	27.00 b	4.60 b
ITA_RUN_N20	0.84	0.73	0.74	0.94	0.02	0.04	1.39	15.28	14.00 a	54.00 a	3.33	123	18.70 a	5.70 b
MEX_COR_YP	0.68	0.24	0.31	0.78	0.05	0.18	1.42	81.77	22.20 b	46.40 b	2.94	200	7.00 a	5.20 a
NLD_LOO	0.55	0.31	0.27	0.74	0.02	0.24	1.33	41.67	1.00 a	99.00 a	2.61	200	18.00 a	2.20 a
NLD_SPE_DOU	0.76	0.60	0.63	0.81	0.09	0.11	1.42	39.80	4.80 b	80.70 b	1.62	200	30.00 a	4.50 a
NZL_HUA_HUA	0.71	0.62	0.61	0.75	0.17	0.08	2.62	42.52	71.20 a	13.20 a	1.73	200	27.00 a	6.60 b
PRT_LEZ_ARN	0.70	0.23	0.25	0.77	0.02	0.21	0.72	77.42	5.04 a	90.38 a	1.52	200	12.00 a	1.50 a
PRTMIT	0.76	0.47	0.36	0.78	0.18	0.04	0.51	80.80	16.10 b	64.50 b	1.33	200	7.50 a	0.55 a
PRTPIN	0.65	0.50	0.36	0.66	0.33	0.01	0.76	74.76	16.60 b	61.20 b	1.26	200	12.60 a	1.10 b
RUS_CHE_Y4	0.31	0.21	0.23	0.95	0.01	0.04	0.62	34.23	21.10 b	23.20 b	4.96	200	7.00 a	1.30 b
RUSFYO	0.72	0.62	0.62	0.88	0.00	0.12	1.24	30.87	18.20 b	48.80 b	3.77	198	23.50 a	3.50 a
RUSPOG_VAR	0.78	0.49	0.61	0.89	0.00	0.11	0.70	33.02	28.60 b	37.50 b	2.64	200	22.00 a	2.80 b
SEN_SOU_PRE	0.75	0.35	0.16	0.79	0.21	0.00	0.13	43.94	6.00 a	90.00 a	0.23	200	7.00 a	0.22 a
SWE_NOR_ST1_BEF	0.75	0.62	0.62	0.68	0.19	0.13	1.07	36.70	5.80 a	58.60 a	2.63	185	28.70 a	4.18 a
SWE_NOR_ST2	0.26	0.21	0.17	0.56	0.00	0.44	1.07	36.70	5.80 a	58.60 a	2.63	185	27.70 a	6.15 a
SWE_NOR_ST3	0.62	0.61	0.60	0.67	0.08	0.25	1.07	36.70	5.80 a	58.60 a	2.63	185	27.20 a	4.55 a
SWE_NOR_ST5_REF	0.59	0.62	0.57	0.50	0.20	0.30	1.07	36.55	19.20 b	43.50 b	2.83	190	20.00 a	5.00 a

C.2. Tables C

Table C.3: Summary table of site level R^2_{VPD} , R^2_{SWC} , R^2_{PPFD} , climate, soil properties and vegetation structure data. PPET is in [mm mm⁻¹], P-PET_{sd} is in [mm], Clay and Sand are in [%], Total N is in [g kg⁻¹], Stand height is in [m], LAI is in [$m^2_{leaves} m^2_{soil}$]. Letters show data source: a = SAPFLUXNET, b = Global rasters, c = SAPFLUXNET plant height. (*continued*)

Site code	R^2_{VPD}	R^2_{SWC}	R^2_{PPFD}	Relimp VPD	Relimp SWC	Relimp PPFD	PPET	P - PET _{sd}	Clay	Sand	Total N	Bedrock	Stand height	LAI
SWE_SKO_MIN	0.76	0.74	0.70	0.55	0.04	0.41	1.60	45.86	17.30 b	52.00 b	2.48	133	28.00 a	6.50 a
SWE_SKY_38Y	0.38	0.46	0.40	0.12	0.88	0.00	1.39	33.61	21.70 b	43.80 b	3.93	184	13.60 a	3.98 a
SWE_SKY_68Y	0.38	0.57	0.37	0.10	0.76	0.14	1.30	33.80	18.90 b	46.50 b	4.15	184	20.30 a	3.83 a
SWE_SVA_MIX_NON	0.64	0.47	0.54	0.88	0.11	0.00	1.33	34.34	0.50 a	92.50 a	1.67	200	15.00 a	3.80 b
THA_KHU	0.51	0.38	0.39	0.71	0.25	0.05	0.83	84.24	10.00 a	65.00 a	0.75	200	15.00 a	3.90 a
USA_BNZ_BLA	0.66	0.43	0.56	0.78	0.17	0.06	0.69	33.86	10.30 b	36.80 b	2.57	200	3.00 a	3.60 b
USA_CHE_ASP	0.69	0.34	0.30	0.92	0.02	0.06	1.23	20.06	12.00 a	74.00 a	1.52	200	10.00 a	4.50 a
USA_CHE_MAP	0.71	0.62	0.65	0.81	0.02	0.17	1.22	19.85	6.63 a	59.31 a	2.54	200	18.00 a	3.90 a
USA_DUK_HAR	0.72	0.62	0.68	0.86	0.03	0.10	1.12	41.33	33.90 b	31.00 b	0.76	200	25.00 a	7.03 a
USA_HIL_HF2	0.72	0.67	0.71	0.59	0.00	0.41	1.14	37.46	26.00 a	43.00 a	0.71	200	15.00 a	5.50 a
USA_INM	0.52	0.42	0.47	0.53	0.00	0.47	1.18	39.20	26.70 b	8.00 b	1.05	200	30.00 a	4.90 a
USA_MOR_SF	0.73	0.52	0.50	0.89	0.10	0.01	1.18	39.20	30.00 a	10.00 a	1.05	200	27.00 a	5.00 a
USA_NWH	0.87	0.82	0.70	0.84	0.03	0.14	1.05	59.56	36.70 b	4.90 b	0.80	200	22.70 a	5.60 b
USA_ORN_ST1_AMB	0.64	0.62	0.56	0.52	0.08	0.41	1.14	61.36	24.00 a	21.00 a	0.85	200	17.90 a	5.50 a
USA_PAR_FER	0.49	0.16	0.23	0.68	0.03	0.29	1.32	25.96	10.00 a	60.00 a	1.75	200	18.00 a	4.20 a
USA_PER_PER	0.61	0.30	0.33	0.80	0.01	0.19	1.32	34.41	3.40 b	89.20 b	6.13	200	12.00 a	4.10 a
USA_PJS_P04_AMB	0.46	0.15	0.31	0.78	0.12	0.10	0.25	49.32	6.00 a	52.00 a	0.82	186	4.20 a	0.71 a
USA_PJS_P08_AMB	0.50	0.16	0.26	0.93	0.07	0.00	0.25	49.32	3.00 a	49.00 a	0.82	186	4.10 a	0.90 a
USA_PJS_P12_AMB	0.36	0.17	0.11	0.65	0.30	0.05	0.25	49.32	6.00 a	54.00 a	0.82	186	4.00 a	0.72 a
USA_SIL_OAK_1PR	0.44	0.49	0.41	0.33	0.49	0.18	1.36	38.70	1.00 a	98.00 a	0.74	200	9.50 a	3.60 a
USA_SIL_OAK_2PR	0.43	0.33	0.39	0.94	0.06	0.00	1.36	38.70	1.00 a	98.00 a	0.74	200	9.50 a	3.60 a
USA_SMI_SER	0.58	0.46	0.39	0.64	0.29	0.06	1.03	40.05	28.70 b	30.90 b	0.82	200	40.00 a	5.80 b
USA_SWH	0.82	0.56	0.52	0.92	0.02	0.06	1.09	62.29	43.10 b	6.30 b	0.69	200	24.20 a	4.00 b
USA_SYL_HL1	0.57	0.42	0.44	0.92	0.08	0.00	1.27	25.01	8.90 b	51.00 b	1.41	200	27.00 a	5.40 b
USA_SYL_HL2	0.53	0.50	0.50	0.66	0.02	0.31	1.27	25.01	8.90 b	51.00 b	1.41	200	27.00 a	5.40 b
USA_TNB	0.31	0.33	0.30	0.37	0.13	0.50	1.39	48.33	21.60 b	34.90 b	0.84	200	25.00 a	4.70 a
USA_TNO	0.38	0.39	0.37	0.41	0.22	0.38	1.41	60.02	29.60 b	30.20 b	0.83	200	30.00 a	6.60 a
USA_TNP	0.34	0.38	0.31	0.50	0.18	0.32	1.41	61.60	31.60 b	26.60 b	0.81	200	25.00 a	4.50 a
USA_UMB_CON	0.61	0.46	0.44	0.76	0.02	0.22	1.30	30.60	1.00 a	92.00 a	2.02	200	29.00 a	3.50 a

Table C.3: Summary table of site level R^2_{VPD} , R^2_{SWC} , R^2_{PPFD} , climate, soil properties and vegetation structure data. PPET is in [mm mm⁻¹], P-PET_{sd} is in [mm], Clay and Sand are in [%], Total N is in [g kg⁻¹], Stand height is in [m], LAI is in [m²_{leaves} m²_{soil}]. Letters show data source: a = SAPFLUXNET, b = Global rasters, c = SAPFLUXNET plant height. (*continued*)

Site code	R^2_{vpd}	R^2_{swc}	R^2_{ppfd}	Relimp VPD	Relimp SWC	Relimp PPFD	PPET	P - PET _{sd}	Clay	Sand	Total N	Bedrock	Stand height	LAI
USA_UMB_GIR	0.57	0.43	0.39	0.76	0.05	0.19	1.25	30.69	1.00 a	92.00 a	2.49	200	29.00 a	3.50 a
USA_WIL_WC1	0.54	0.30	0.23	0.81	0.18	0.01	1.19	20.23	6.90 b	53.20 b	1.01	200	24.30 a	6.20 b
USA_WVF	0.43	0.35	0.35	0.65	0.02	0.33	1.63	30.35	24.90 b	29.90 b	1.37	200	30.00 a	6.90 a
ZAF_FRA_FRA	0.61	0.08	0.24	0.96	0.01	0.03	0.90	99.17	20.00 b	69.90 b	0.95	200	20.00 a	1.80 a
ZAF_RAD_RAD	0.45	0.33	0.32	0.58	0.06	0.37	0.95	82.73	21.30 b	61.40 b	1.18	200	3.50 a	2.70 a
ZAF_SOU_SOU	0.43	0.18	0.17	0.58	0.05	0.38	0.97	86.39	23.00 b	61.90 b	1.13	200	4.00 a	3.00 a
ZAF_WEL_SOR	0.63	0.29	0.32	0.66	0.05	0.29	0.50	79.71	20.00 a	60.00 a	0.81	179	25.00 a	1.80 a

Table C.4: Table of equivalence between Whittaker biomes and the groups of biomes used in the study.

Original biome name	Study biome group
Desert	DRY
Temperate grassland desert	DRY
Subtropical desert	DRY
Woodland/shrubland	WOOD
Temperate forest	TEMP
Boreal forest	BOR
Tundra	BOR
Tropical rainforest	TROP
Tropical seasonal forest/savanna	TROP

Table C.5: Average contribution of the predictors in models of individual coupling (R^2_{VPD} , R^2_{SWC} , R^2_{PPFD} and R^2_{TOTAL}) estimated using dominance analysis. $\log(PPET)$: logarithm of precipitation over potential evapotranspiration, $\log(P-PET_{sd})$: logarithm of the standard deviation of the difference between precipitation and potential evapotranspiration, LAI: leaf area index. NI means that the variable was not included in the model after model selection.

G_{Asw} coupling	$\log(PPET)$	$\log(P - PET_{sd})$	Clay	Total Nitrogen	Bedrock depth	Stand Height	LAI
R^2_{VPD}	0.04	0.003	0.04	0.029	NI	0.06	0.015
R^2_{SWC}	0.11	NI	0.05	NI	0.002	0.05	NI
R^2_{PPFD}	0.08	0.002	0.04	0.052	NI	0.11	0.017
R^2_{TOTAL}	0.04	NI	0.06	0.031	NI	0.01	NI

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D

Appendix Chapter 5

D.1 Notes D

Notes S1: Whole-tree stomatal conductance (G'_{Asw}) calculation procedure.

To account for aerodynamic effect on whole-tree canopy conductance (G_{Asw}) in trees were wind speed was available, we subtracted from G_{Asw} (calculated with eq. 2 of the main text) the aerodynamic conductance calculated following Tan *et al.* 2019. We first calculate the aerodynamic conductance for momentum (eq. 14 in Tan *et al.* 2019):

$$g_{aM} = \frac{\kappa^2 u}{\ln[(z - d)/z_{0M}] \ln[(z - d)/z_{0H}]} \quad (\text{D.1})$$

Where κ is the Von Karman constant and equivalent to 0.41 and u is wind speed [$m s^{-1}$] and:

$$z = \text{tree height} + 2, d = 0.6(\text{tree height}), z_{0M} = 0.1(\text{tree height}), z_{0H} = 0.135(z_{0M}) \quad (\text{D.2})$$

Lately, we calculated the boundary layer conductance following eq. 10 in Tan *et al.* (2019):

$$g_{bN} = \frac{\kappa u^*}{\ln\left(\frac{z_{0M}}{z_{0H}}\right)} \quad (\text{D.3})$$

Where u^* [$m s^{-1}$] is the friction velocity calculated inverting eq. 2 in Chu *et al.* 2018:

$$u^* = \frac{\kappa u}{\ln[(z - d)/z_{0M}] + \ln(1.25)} \quad (\text{D.4})$$

Ultimately, G'_{Asw} was calculated as:

$$G'_{Asw} = \left(\frac{1}{1/G_{Asw} - (1/g_{aM} + 1/g_{bN})} \right) \quad (\text{D.5})$$

Being G_{Asw} in [$m s^{-1}$]. Finally, G'_{Asw} was transformed to [$\text{mol } m_{Asw}^{-2} s^{-1}$].

D.2 Figures D

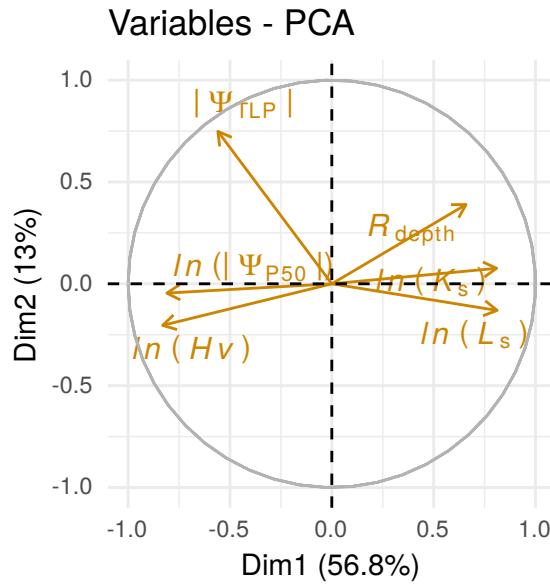
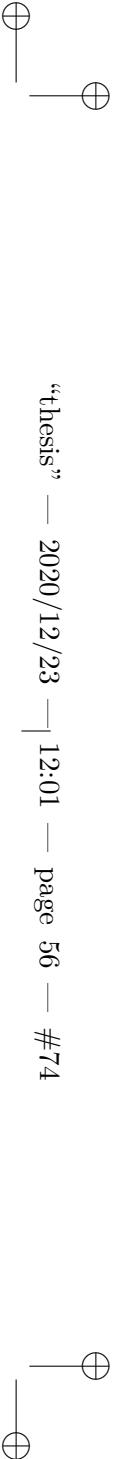


Figure D.1: PCA plot of water relations traits using imputations. $\ln(|\Psi_{P50}|)$: logarithm of absolute water potential at 50% water conductivity loss; $\ln(K_s)$: logarithm of maximum sapwood water conductivity; $\ln(H_v)$: logarithm of Huber value; $|\Psi_{TLP}|$: absolute water potential at turgor-loss point; R_{depth} : rooting depth; $\ln(L_s)$: logarithm of individual leaf area.



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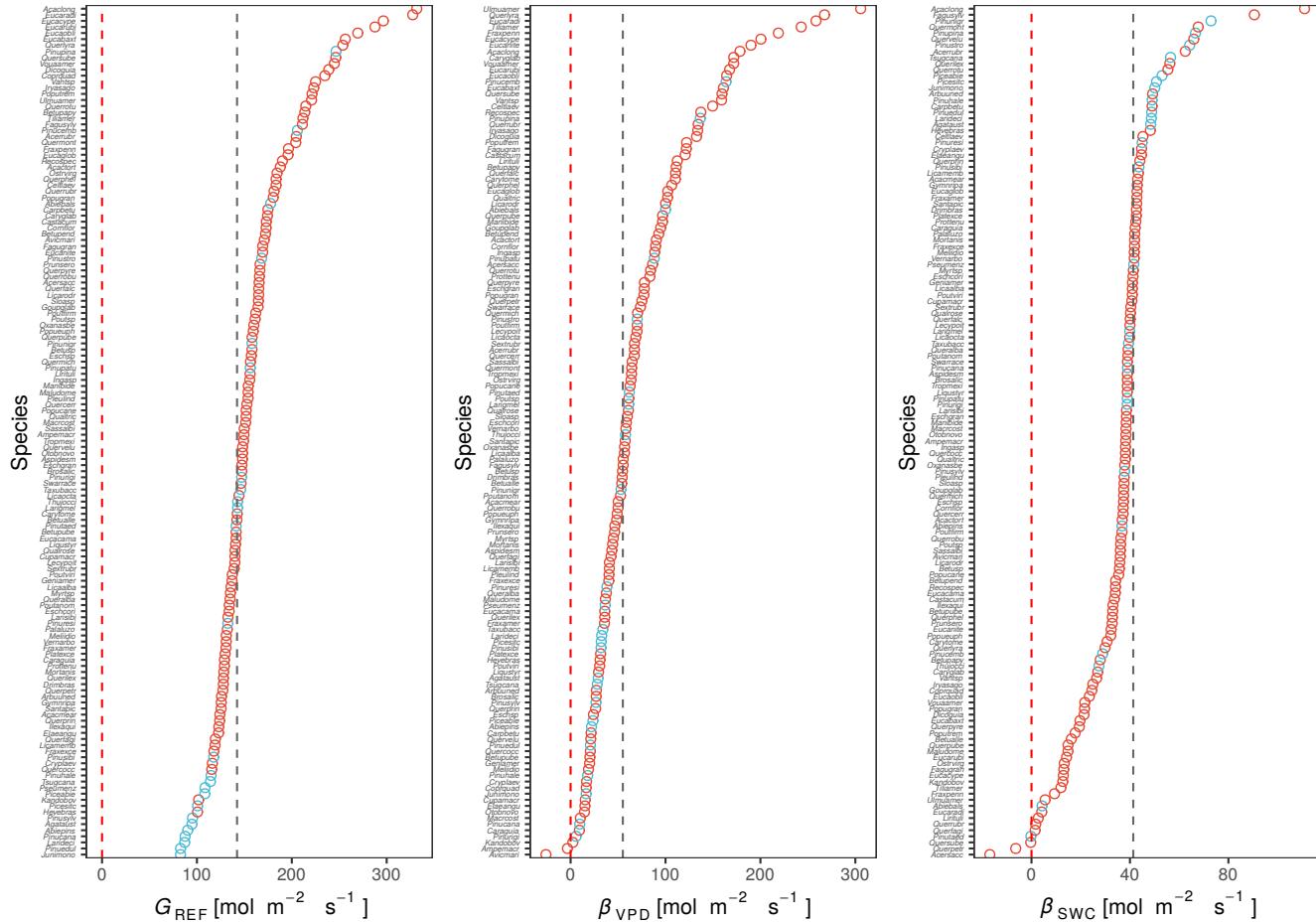
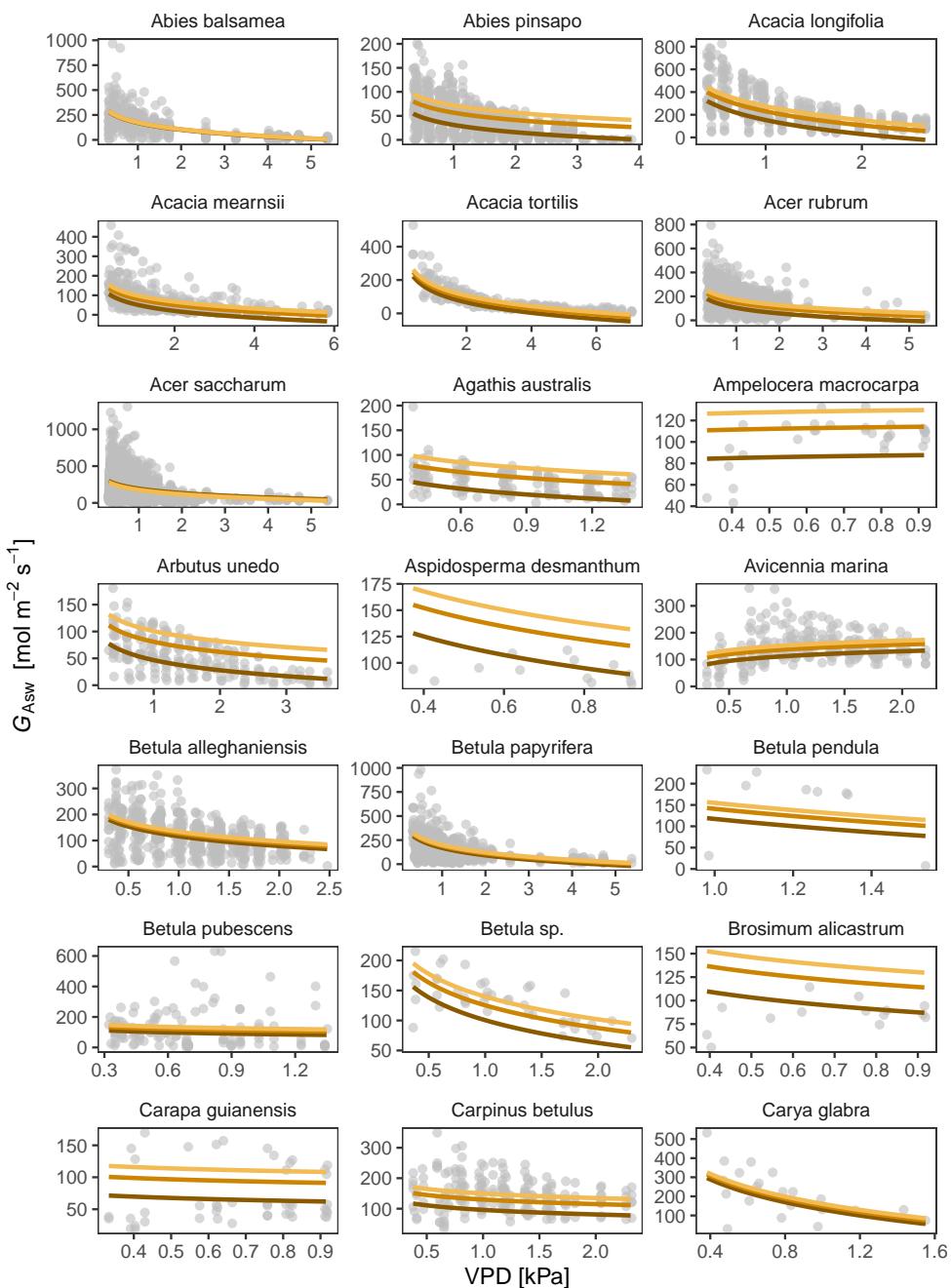
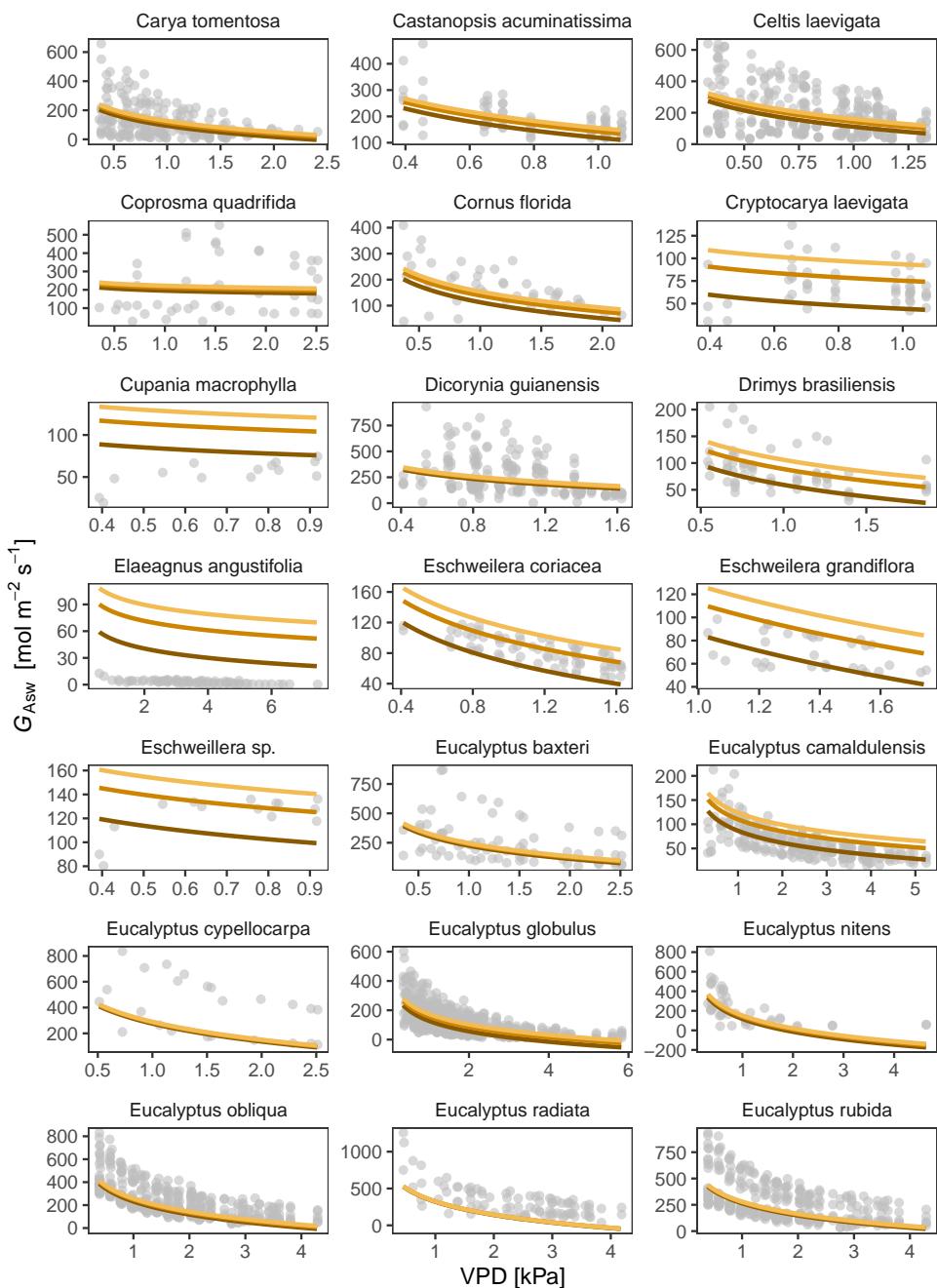
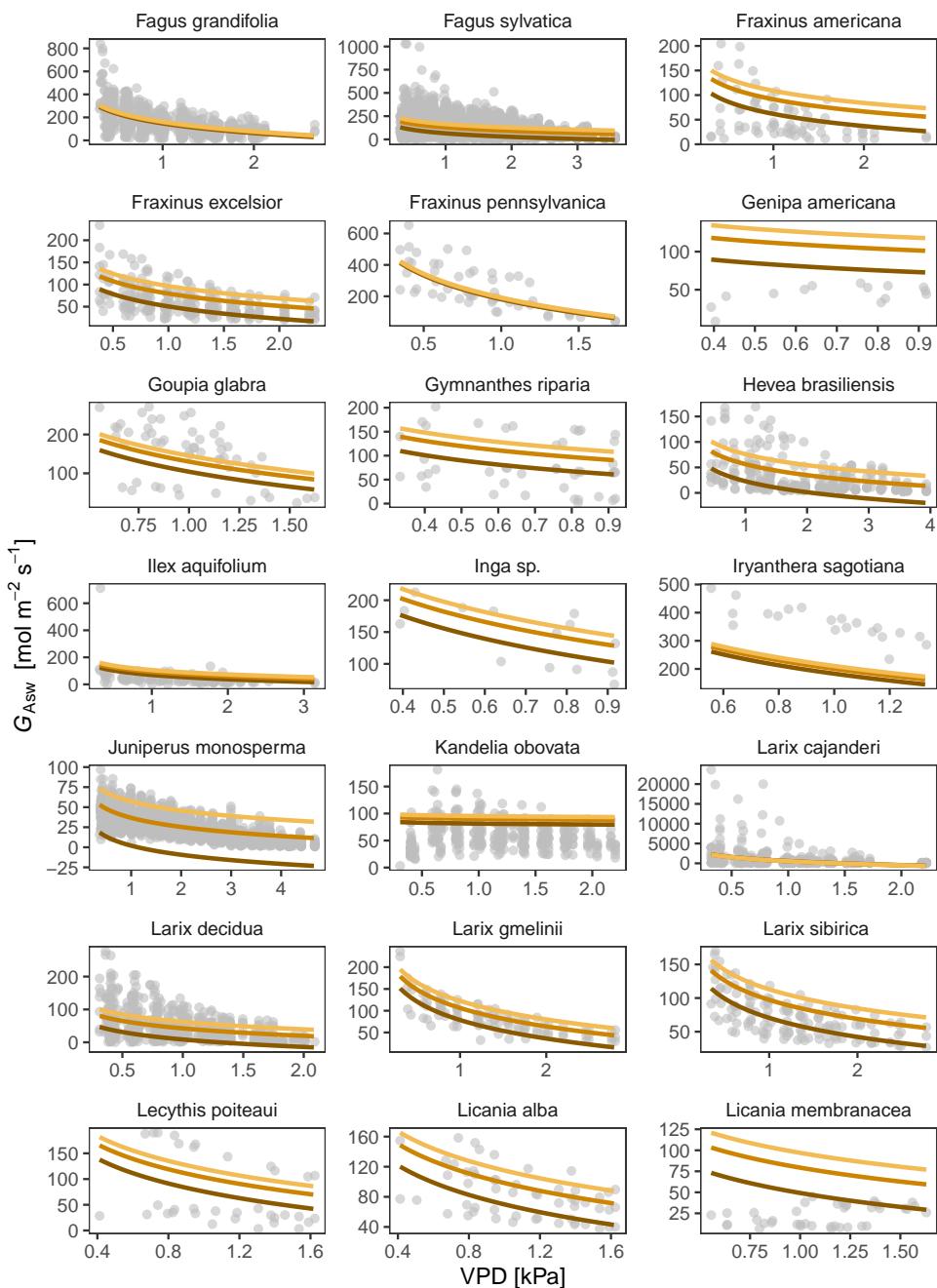


Figure D.2: Water use parameters at the species level. Grey dashed lines are the weighted mean of the parameters

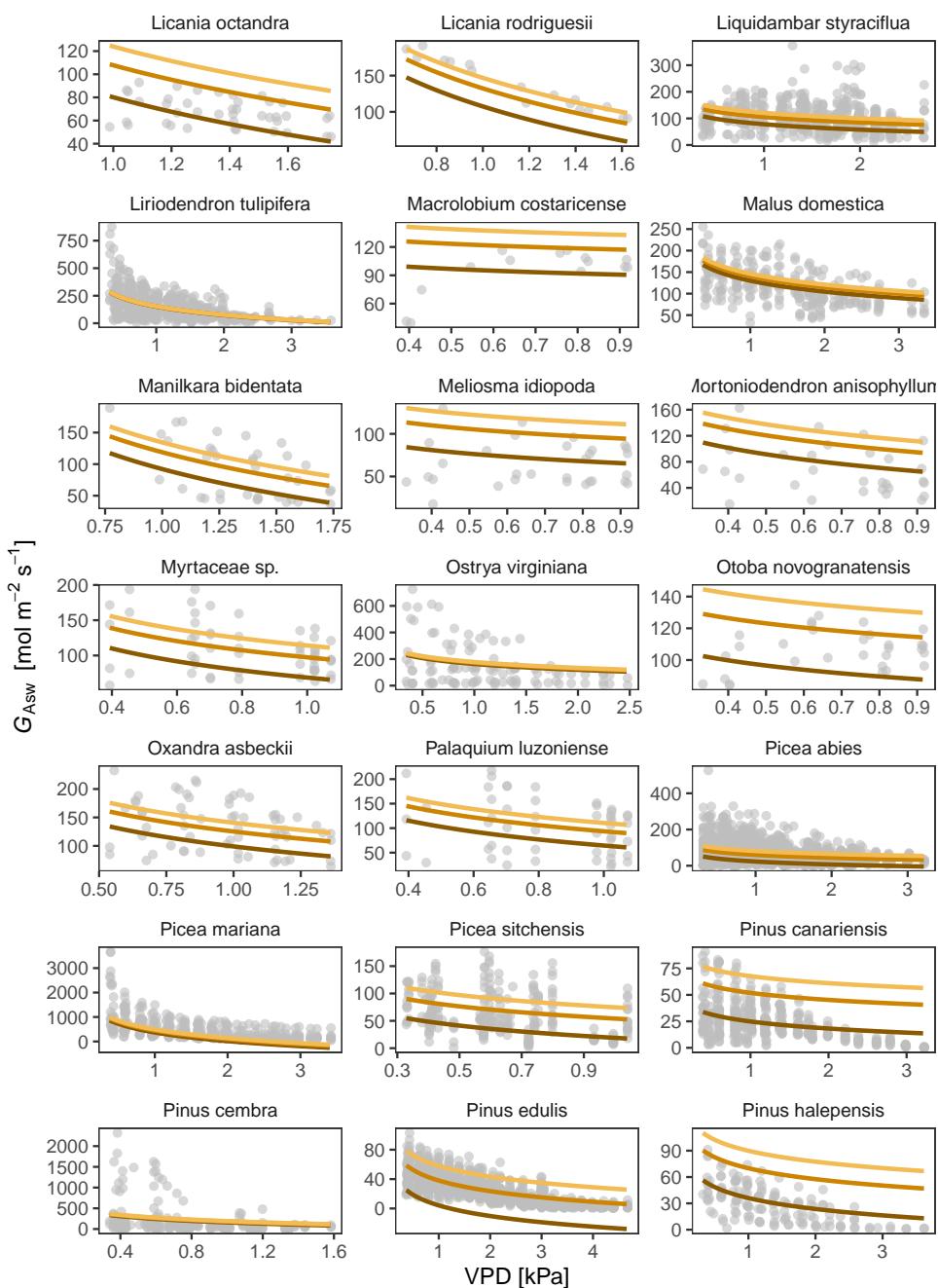


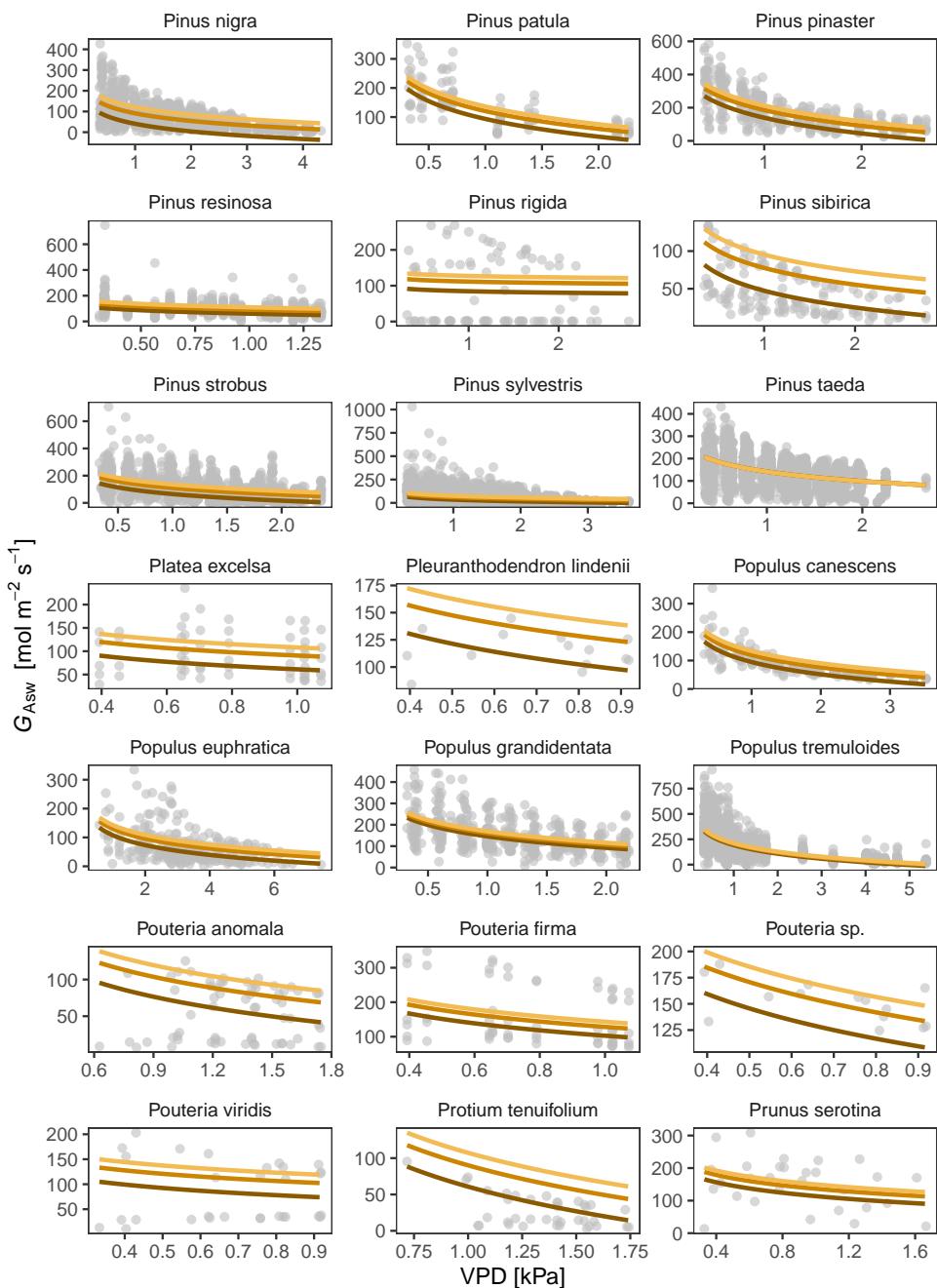
D.2. Figures D





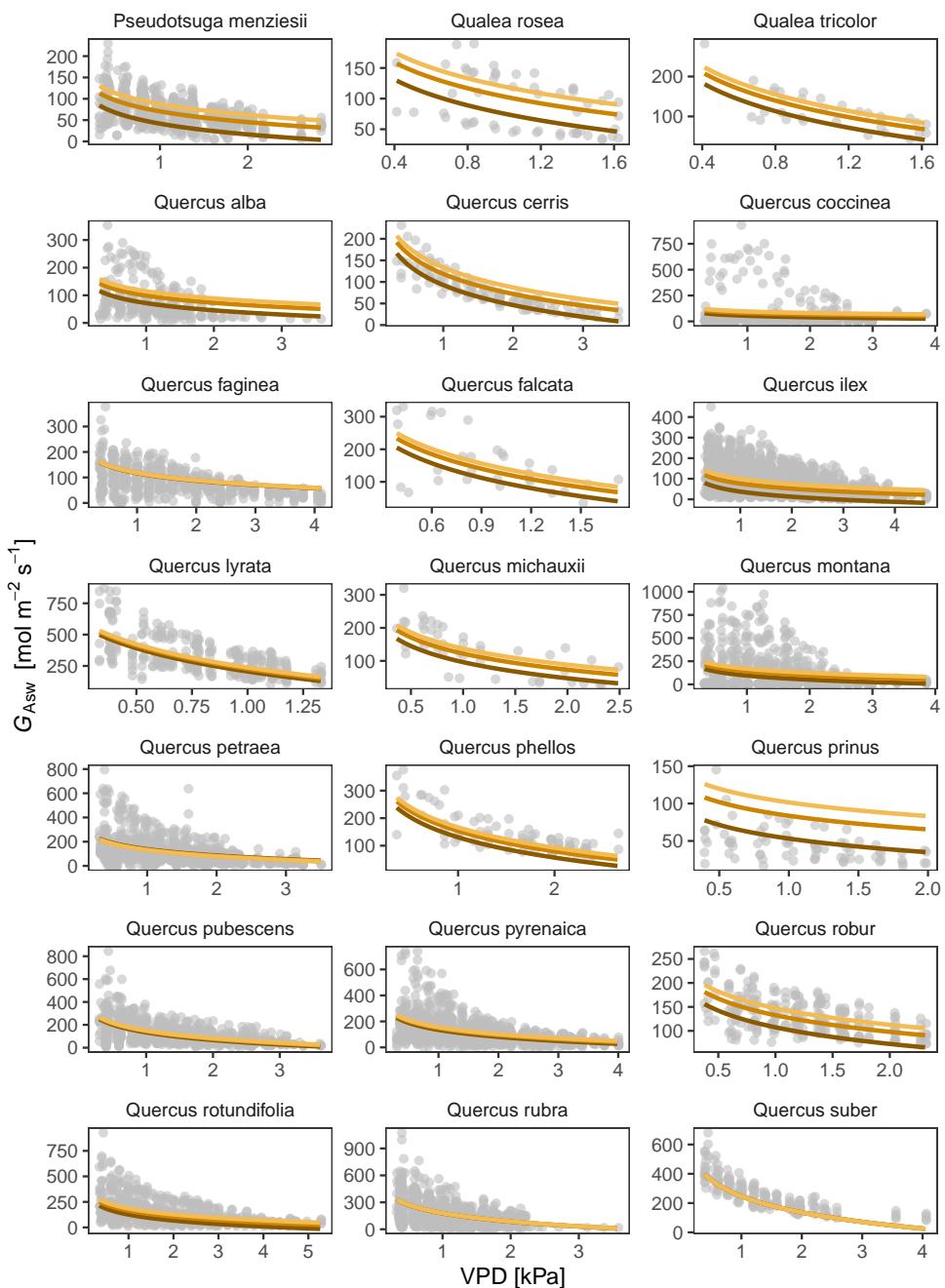
D.2. Figures D





D.2. Figures D

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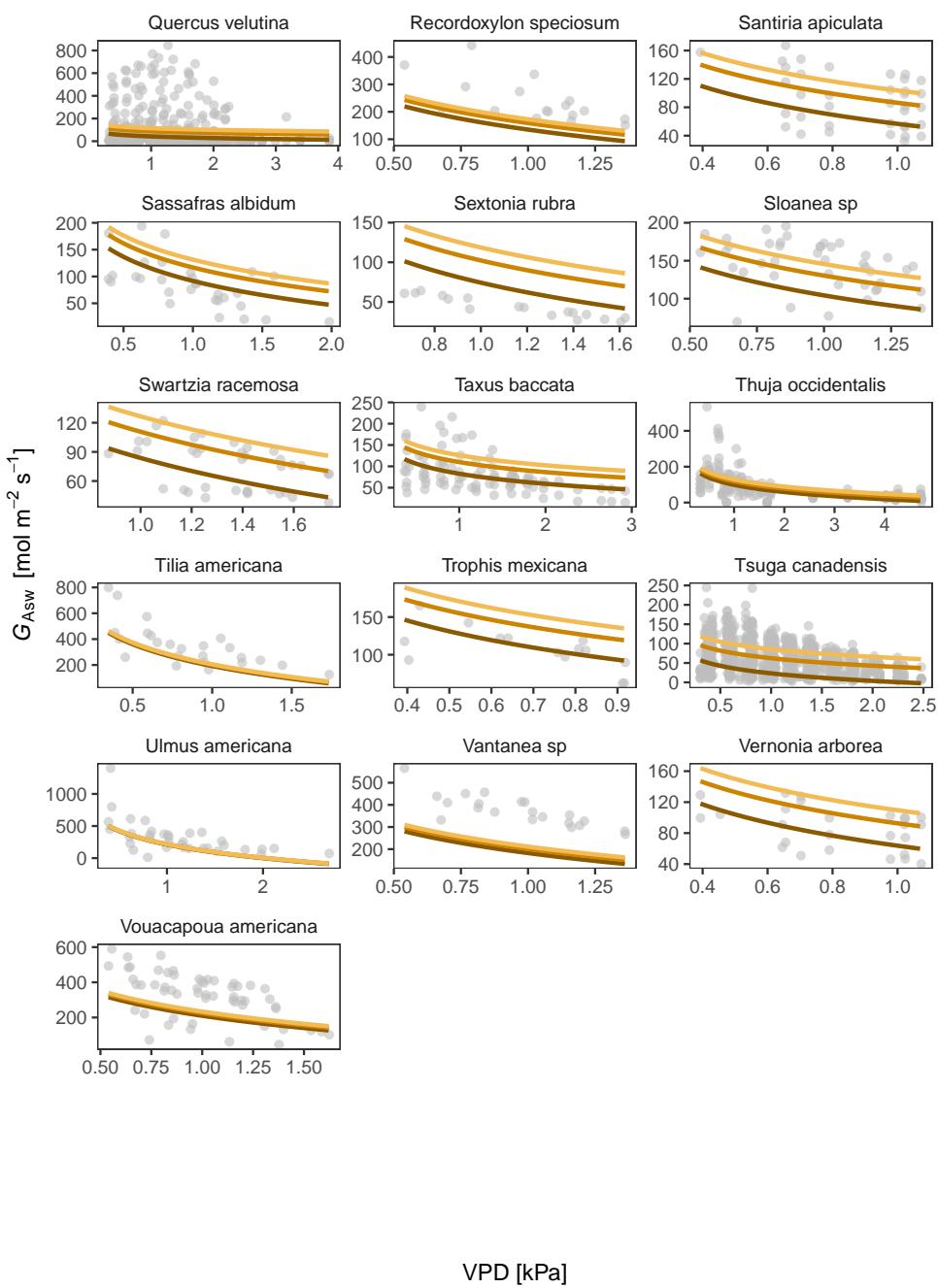
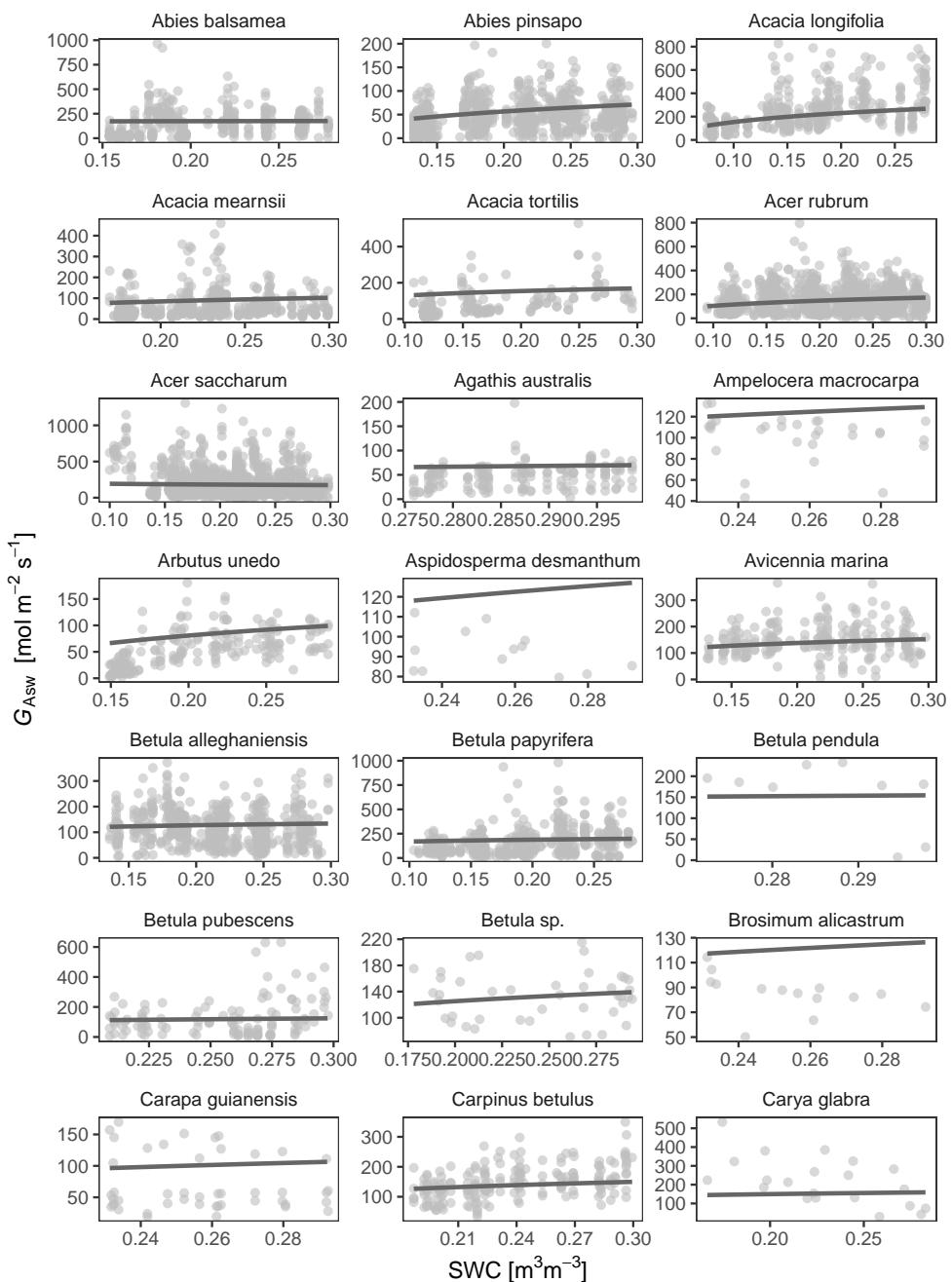
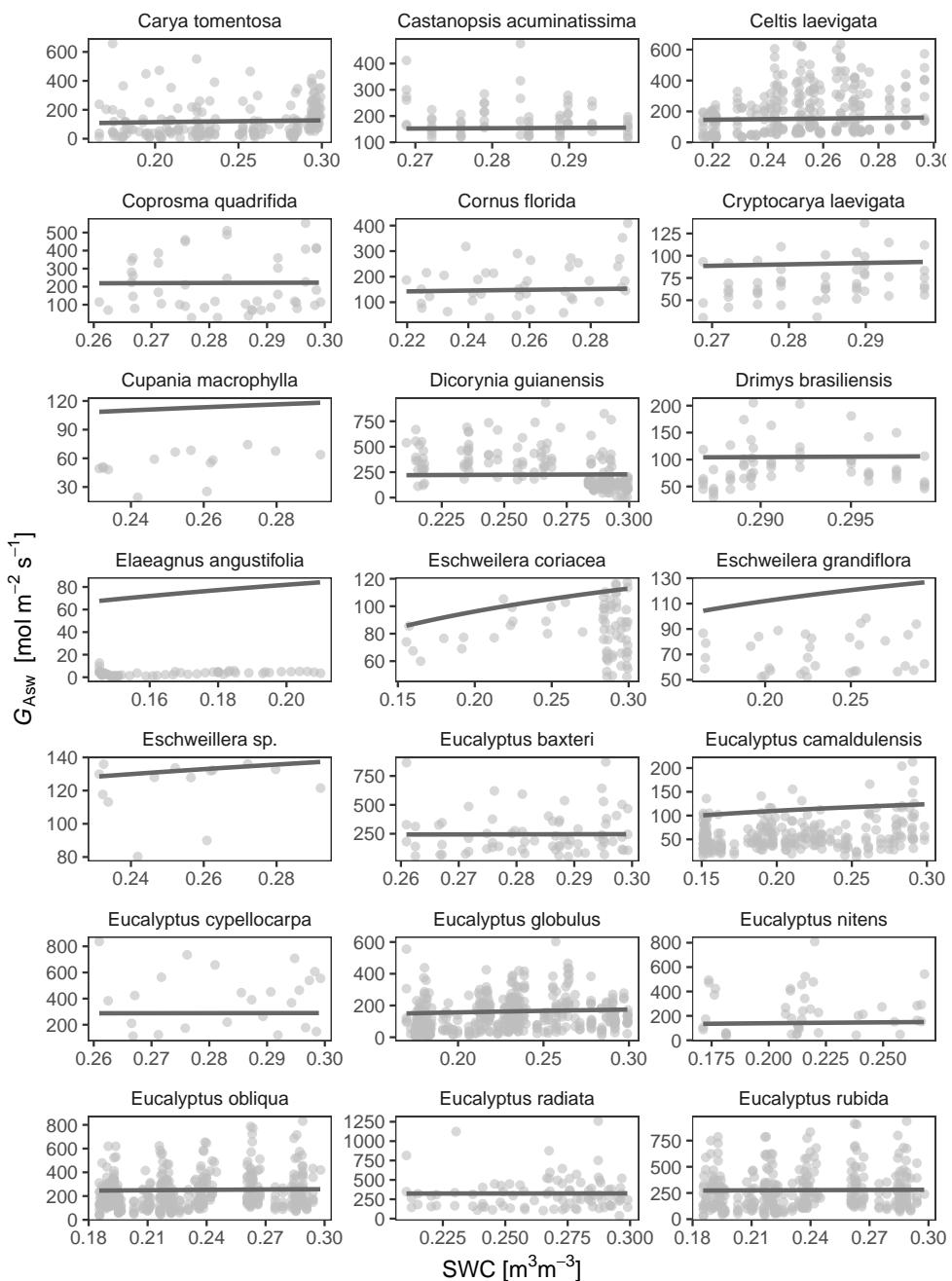


Figure D.3: Species G_{Asw} responses to VPD. Each species have different curves representing distinct levels of SWC (from dark to light, 0.1, 0.2, 0.3 $[m^3 m^{-3}]$).

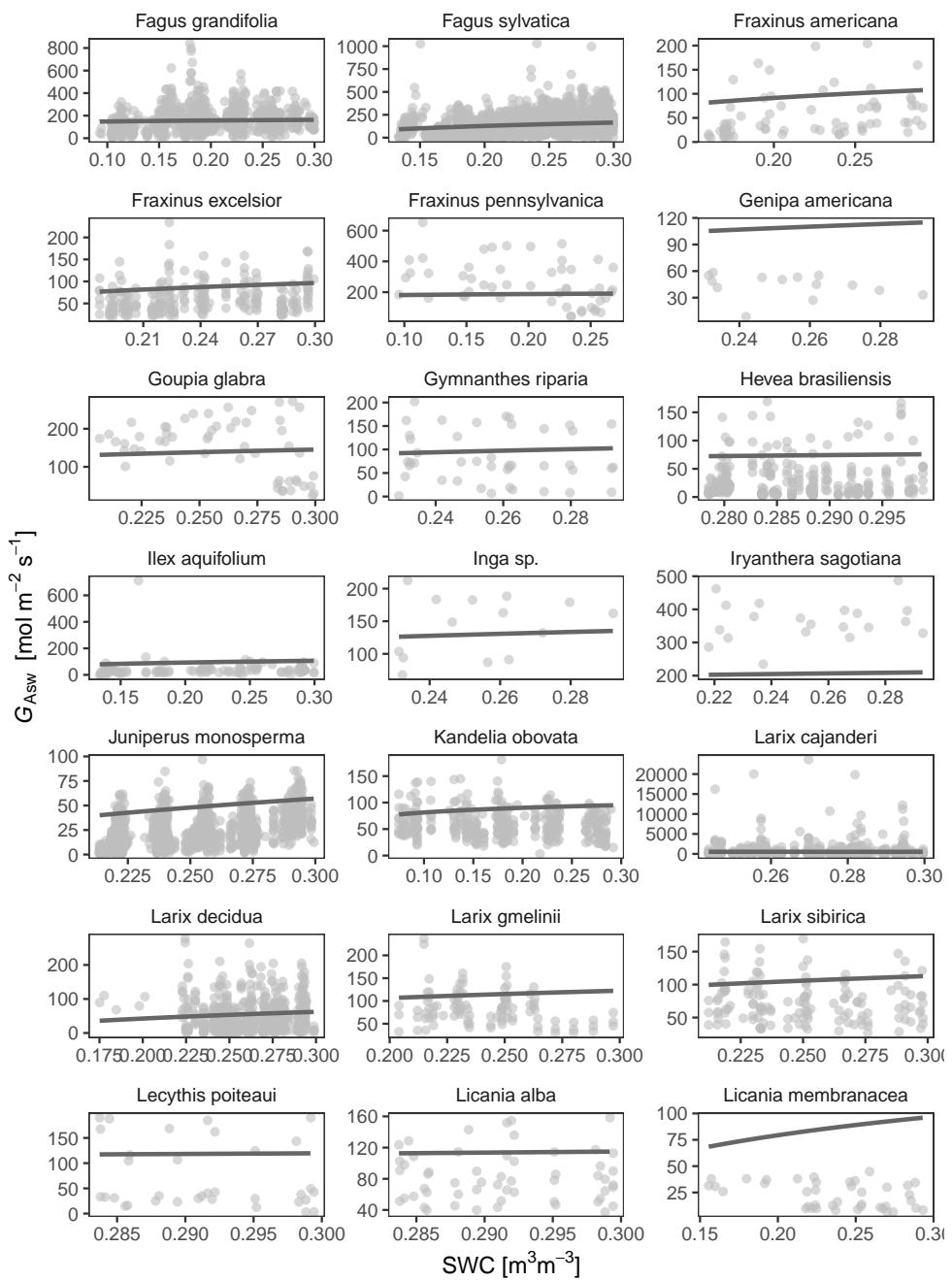
D.2. Figures D

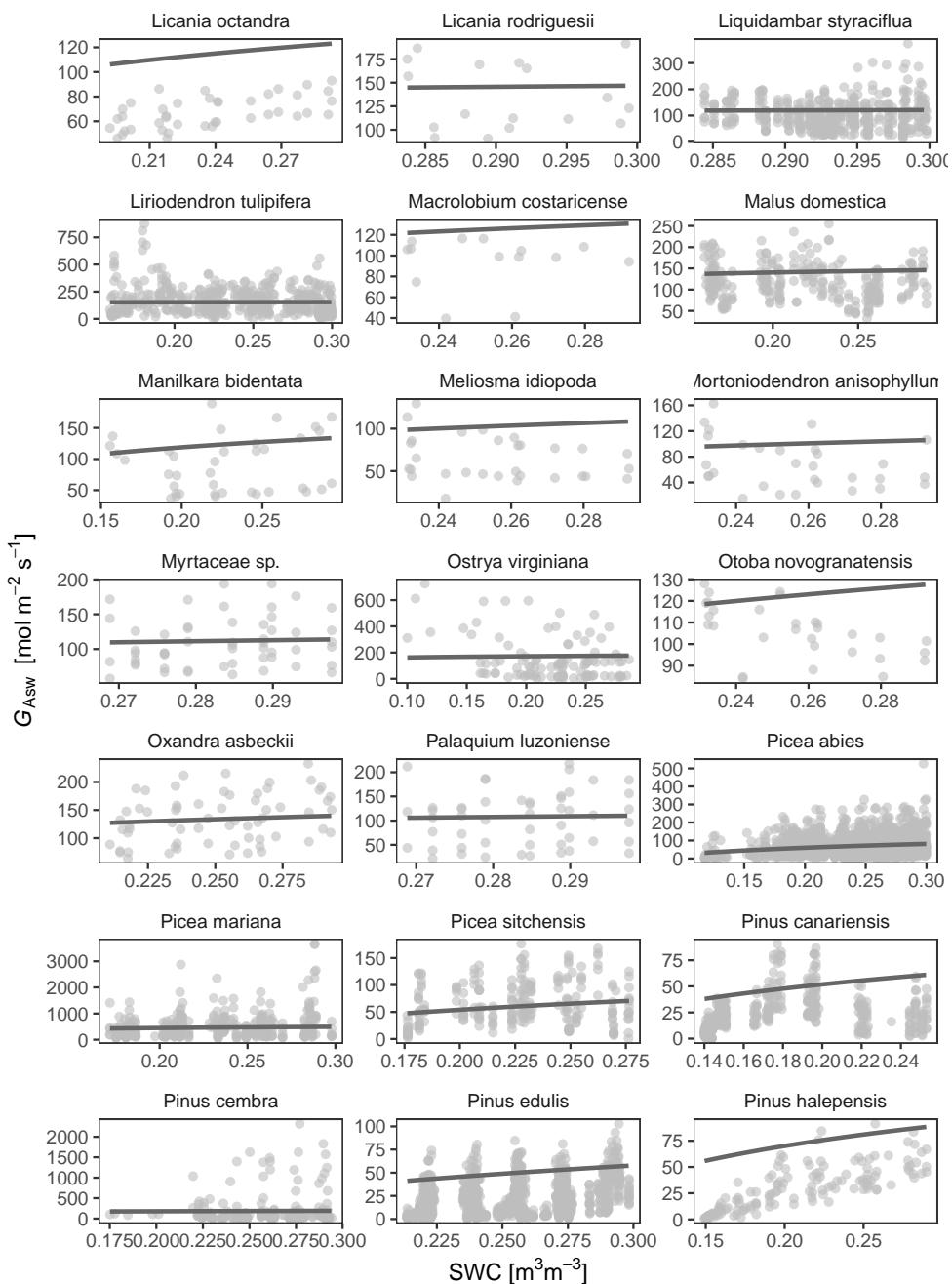




D.2. Figures D

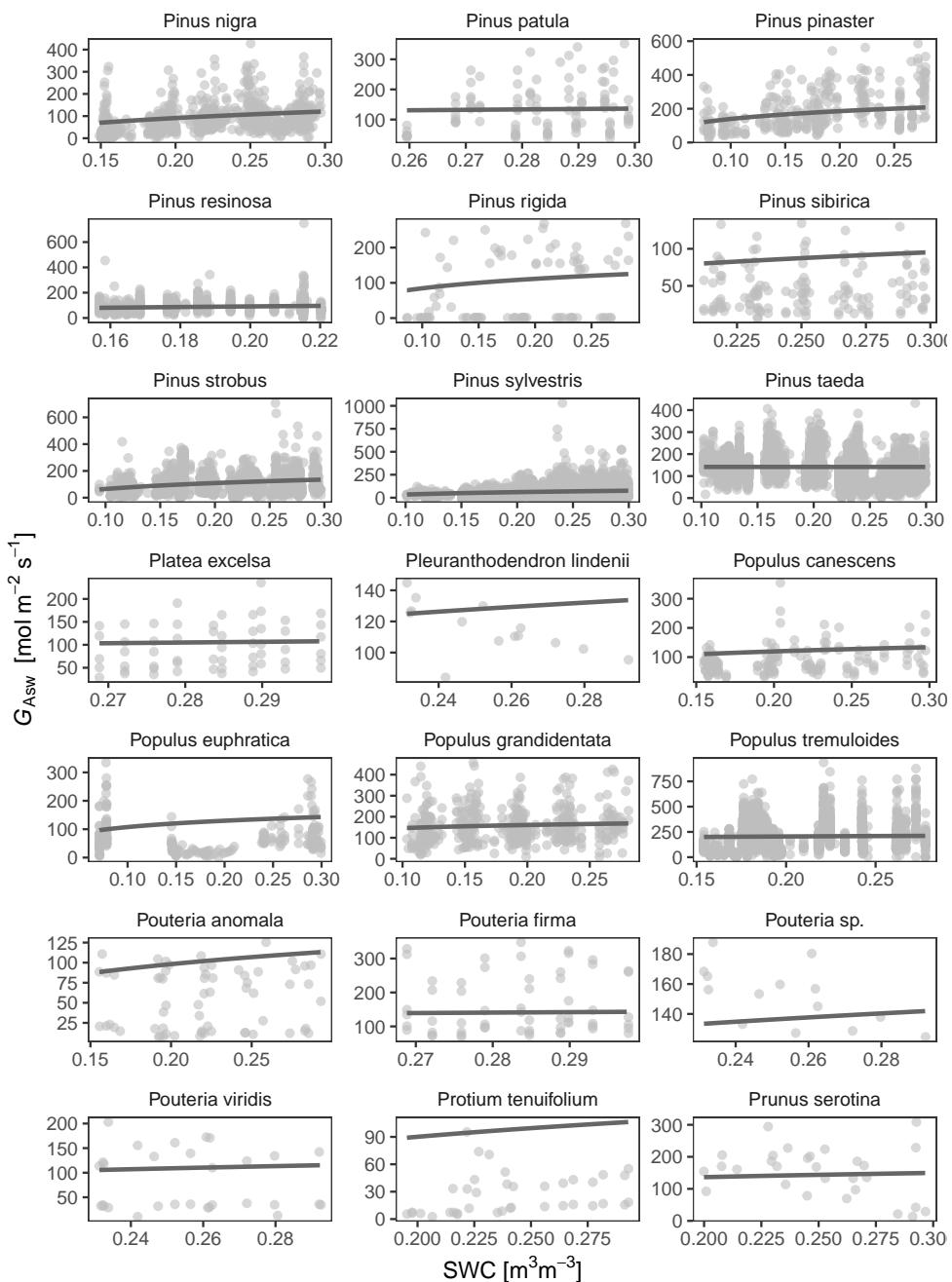
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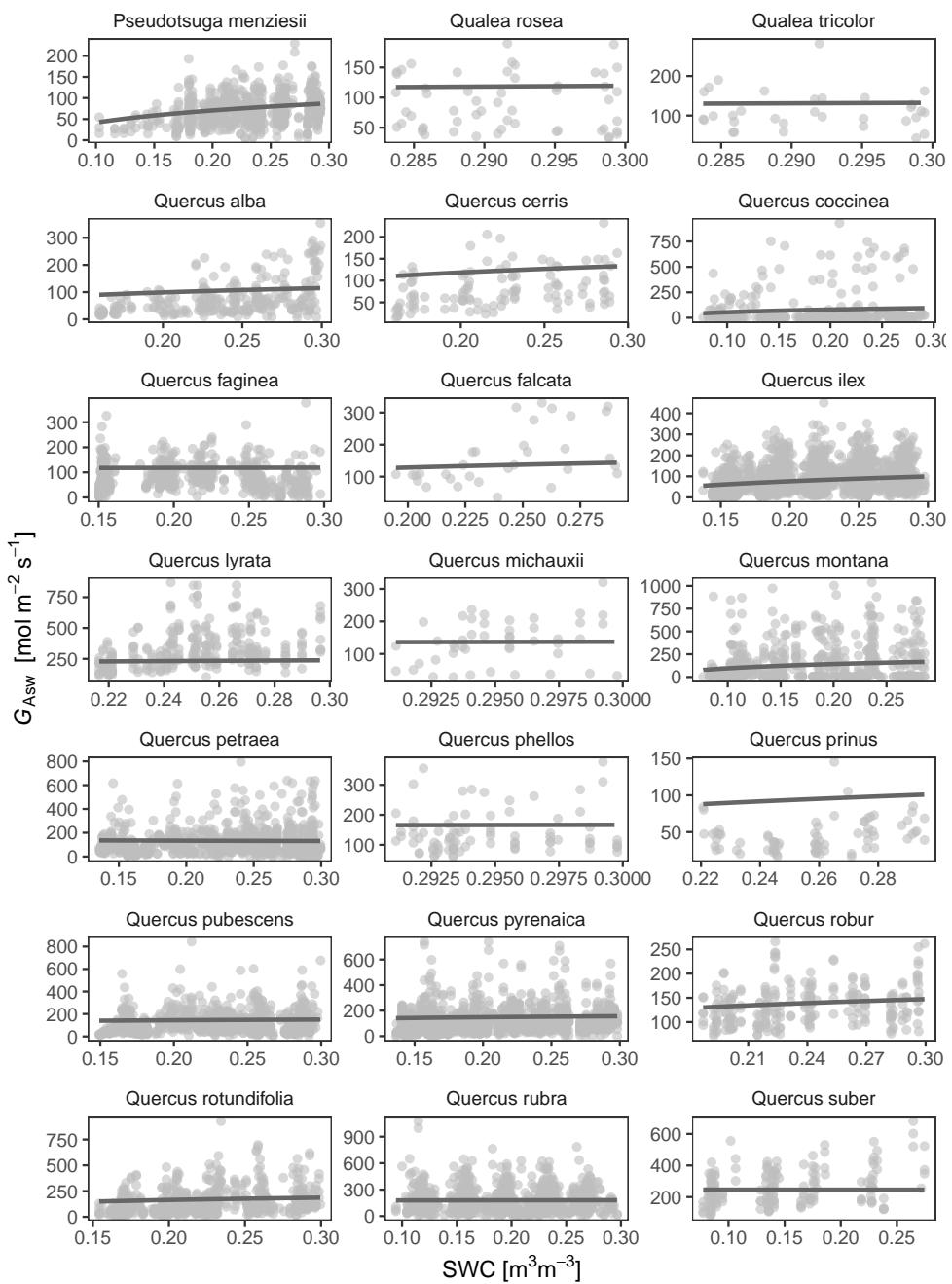




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D.2. Figures D

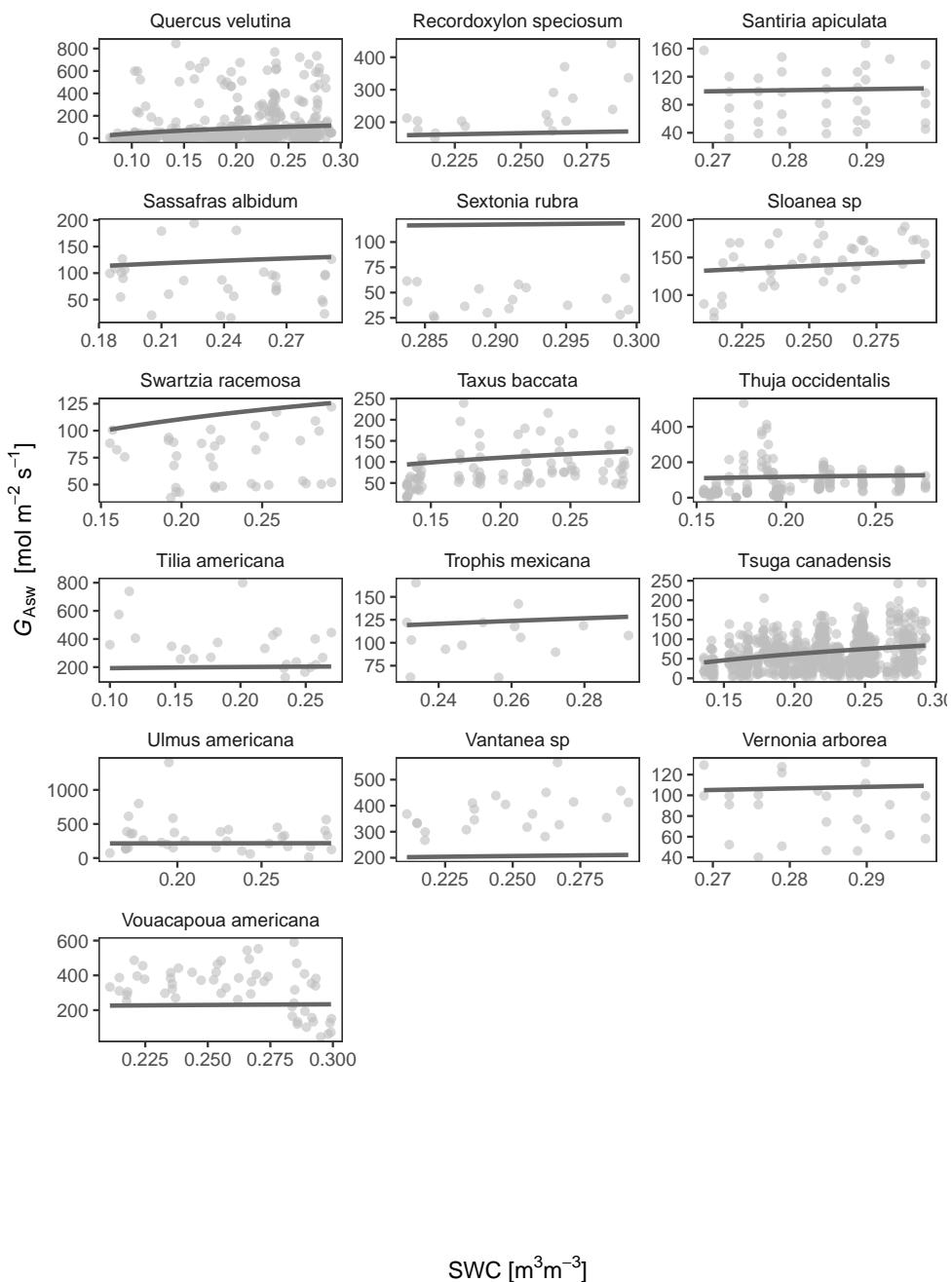


Figure D.4: Species G_{Asw} responses to SWC. Curves are fitted using a VPD reference level of 1 kPa.

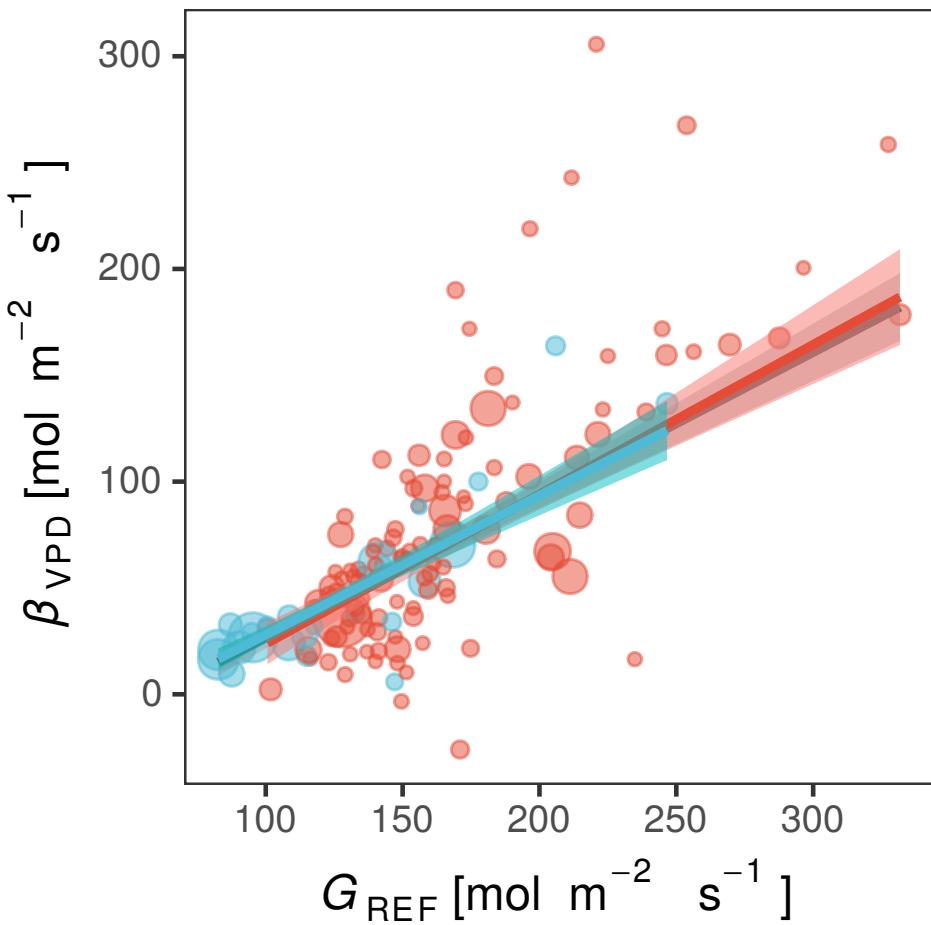


Figure D.5: Scatterplot between G_{REF} and β_{VPD} parameters. Grey line is global relationship. Blue and red lines are angiosperms and gymnosperms relationships, respectively. Shadow areas are 95% confidence interval.

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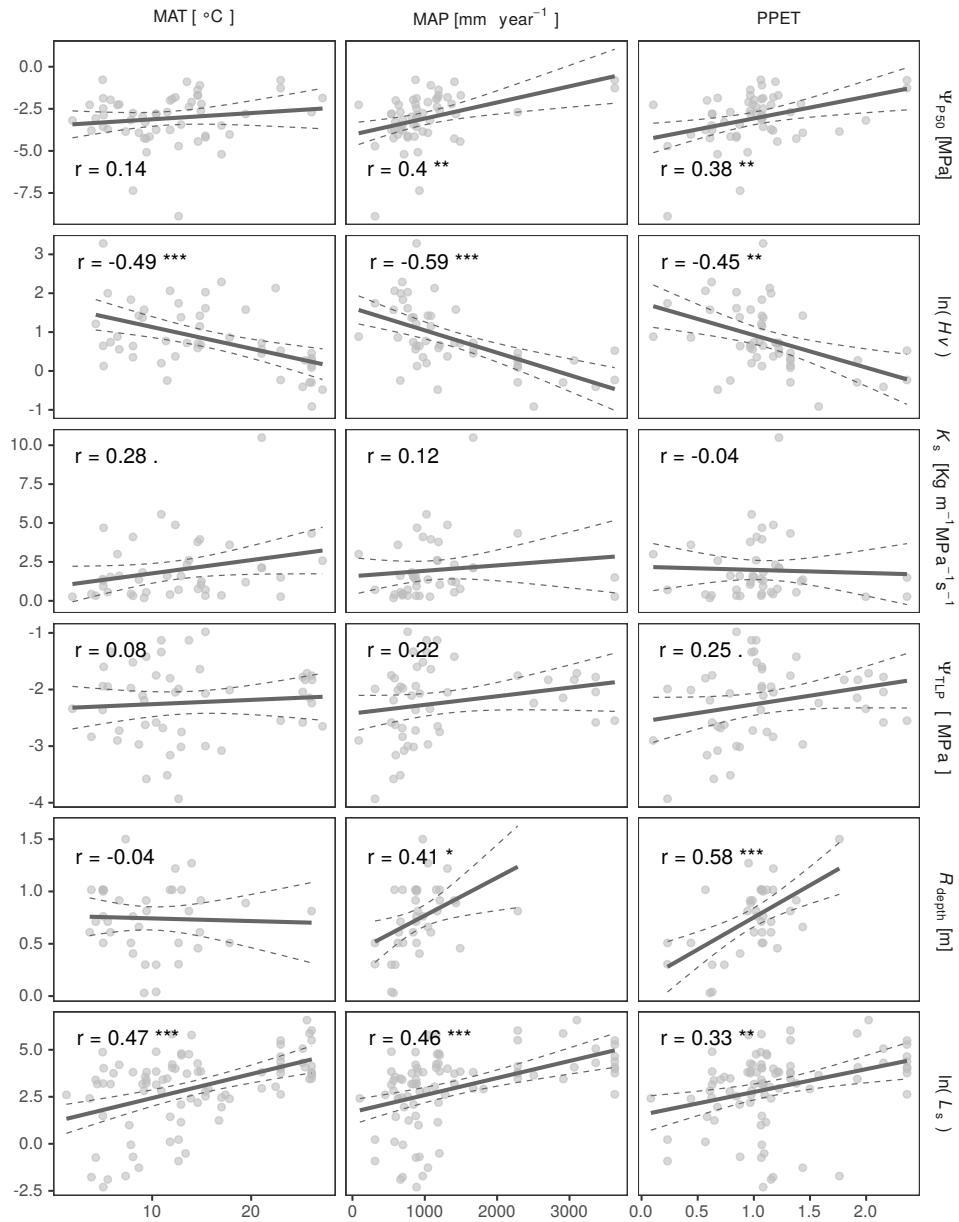


Figure D.6: Species’ climatic variables and water relations traits relationships. MAP: mean annual precipitation, MAT: mean annual temperature, PPET: mean annual precipitation over potential evapotranspiration. All climatic variables were calculated as the weighted average of the characteristic plots of the trees of each species, using tree-days as weighting factor.

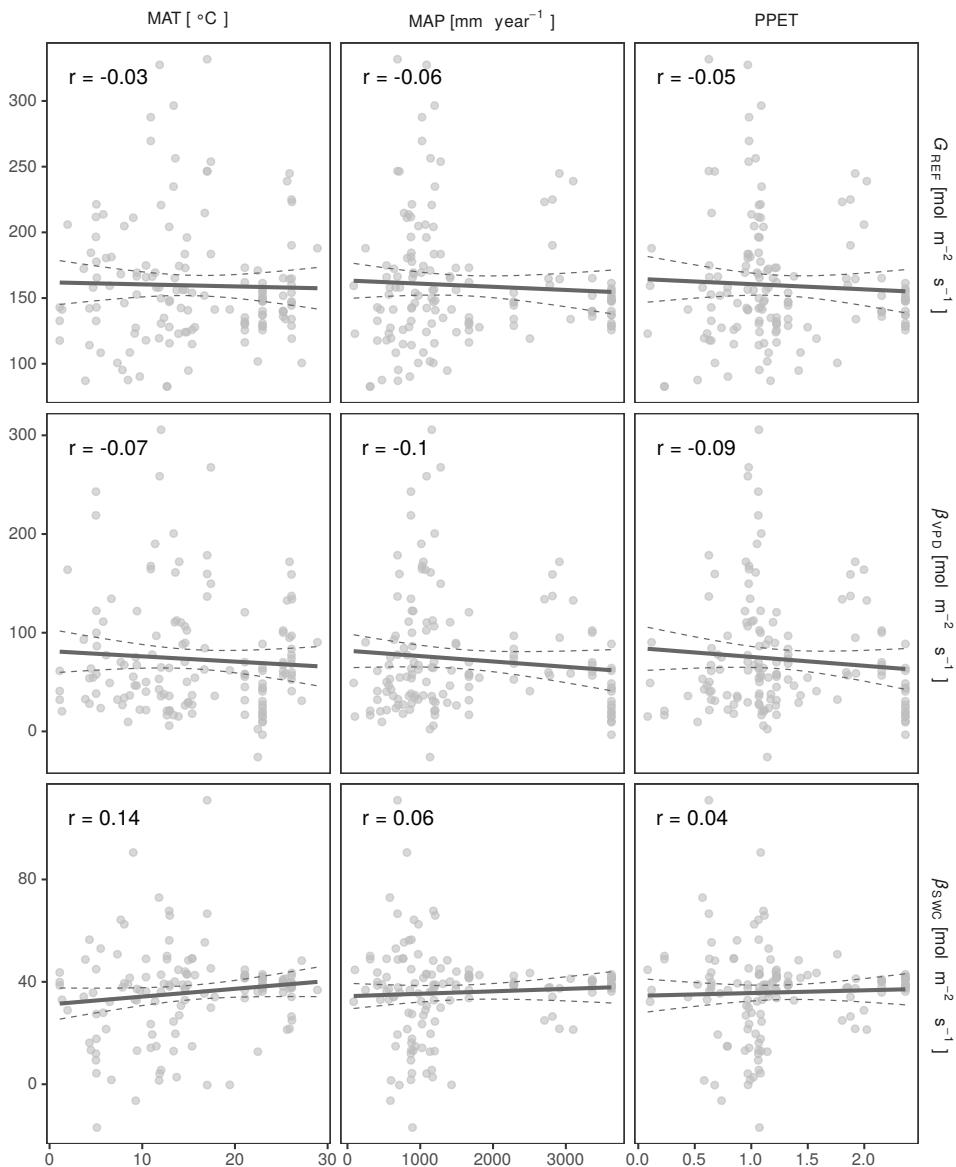


Figure D.7: Species' climatic variables and water use parameters relationships. MAP: mean annual precipitation, MAT: mean annual temperature, PPET: mean annual precipitation over potential evapotranspiration. All climatic variables were calculated as the weighted average of the characteristic plots of the trees of each species, using tree-days as weighting factor.

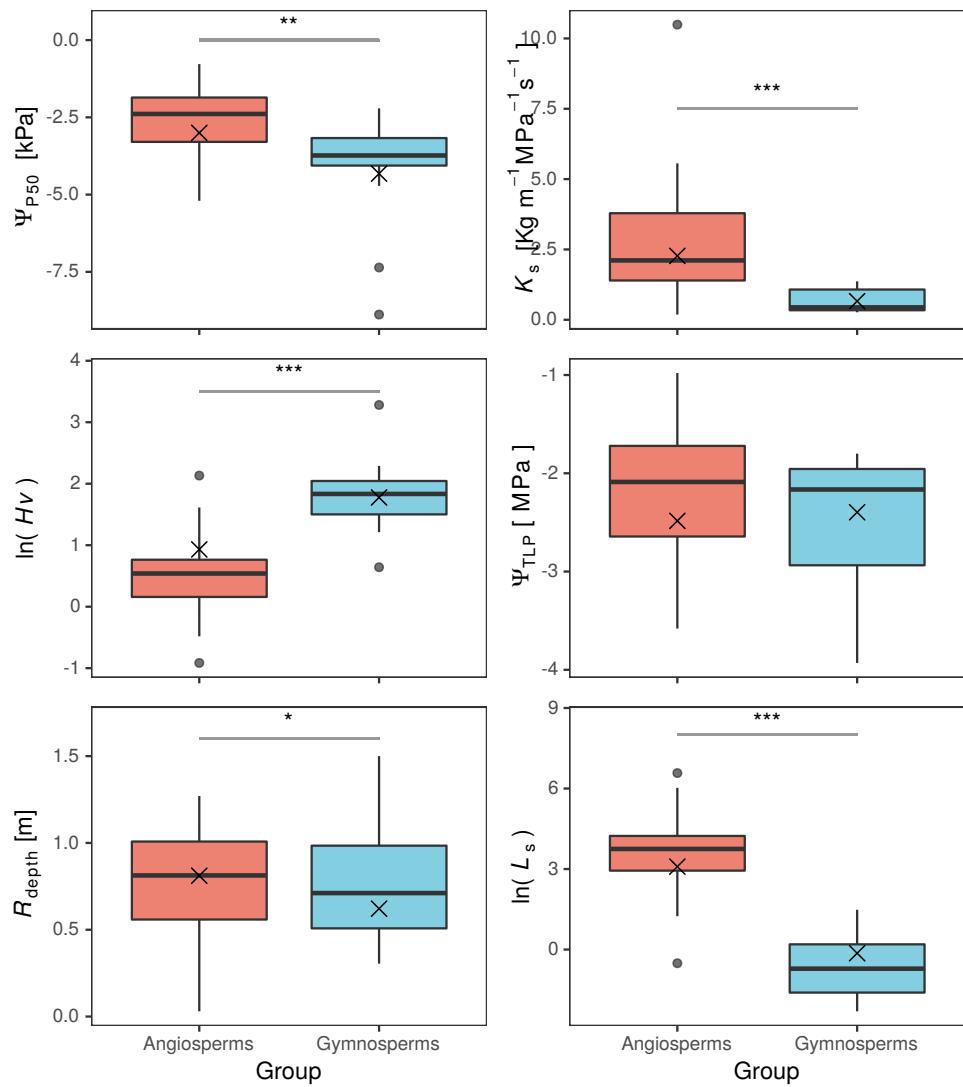


Figure D.8: Boxplots of water relations traits for angiosperms and gymnosperms. Statistical significance level is showed as symbols: ., $P < 0.1$; *, $P < 0.05$; **, $P < 0.01$; ***, $P < 0.001$. Crosses are weighted means of each trait by groups

D.3 Tables D

Table D.1: SAPFLUXNET plot treatments included in this study (Poyatos *et al.* 2020).

Plot treatment
None
Control
control
Ambient Control
Control - Unthinned
natural conditions
Reference
1Premortality
2premortality
distructive sampling
Girdling early successional
Pre-thinning
Before thinning
Before Thinning
non thinned
none (periodict thinning every 5-6 years 20 to 25% of basal area)
Radiation Level
AMBIENT CO2 FACE rings
fertilization at plantation
AcaciaMonoculture
MixtureEucalyptusAndAcacia
EucalyptusMonoculture
Pre Irrigation

D.3. Tables D

Table D.2: Species resume table. CEP names are Cornell Ecology Programs species names. Ψ_{P50} : water potential at 50% water conductivity loss [MPa], K_s : maximum sapwood water conductivity [$\text{Kg m}^{-1} \text{ MPa}^{-1} \text{ s}^{-1}$], H_v : Huber value [$\text{cm}^2_{\text{Asw}} \text{ m}_{\text{leaf area}}^{-2}$], Ψ_{TLP} : water potential at turgor-loss point [MPa], R_{depth} : rooting depth [m], L_s : individual leaf area [cm^2].

Species	CEP names	Group	# tree-days	# trees	# plots	Ψ_{P50}	K_s	Ψ_{TLP}	H_v	R_{depth}	L_s
<i>Abies balsamea</i>	Abiebals	Gymnosperms	855	19	1	-2.479	1.292		26.600	0.508	
<i>Abies pinsapo</i>	Abiepins	Gymnosperms	11822	22	3	-4.150					11.715
<i>Acacia longifolia</i>	Acaclong	Angiosperms	2130	10	1						
<i>Acacia mearnsii</i>	Acacmear	Angiosperms	4555	23	2						4.134
<i>Acacia tortilis</i>	Acactort	Angiosperms	1740	3	1						
<i>Acer rubrum</i>	Acerrubr	Angiosperms	17230	49	9	-2.755	4.108	-1.520	1.422	0.762	44.983
<i>Acer saccharum</i>	Acersacc	Angiosperms	10928	156	8	-2.873	4.695	-1.600	1.134	1.016	55.675
<i>Agathis australis</i>	Agataust	Gymnosperms	1272	6	1	-2.210	1.250				
<i>Ampelocera macrocarpa</i>	Ampemacr	Angiosperms	100	2	1						103.560
<i>Arbutus unedo</i>	Arbuuned	Angiosperms	1900	4	1	-4.198	0.714	-0.980	5.017		12.470
<i>Aspidosperma desmanthum</i>	Aspidesm	Angiosperms	35	1	1						42.925
<i>Avicennia marina</i>	Avicnari	Angiosperms	828	6	1						8.435
<i>Betula alleghaniensis</i>	Betualle	Angiosperms	3750	16	2						20.800
<i>Betula papyrifera</i>	Betupapy	Angiosperms	3869	21	2	-1.966	1.538	-1.330	2.096	0.610	29.938
<i>Betula pendula</i>	Betupend	Angiosperms	9	1	1	-2.265					23.942
<i>Betula pubescens</i>	Betupube	Angiosperms	397	9	2						11.177
<i>Betula sp.</i>	Betusp	Angiosperms	204	2	1						13.510
<i>Brosimum alicastrum</i>	Brosalic	Angiosperms	40	1	1						58.953
<i>Carapa guianensis</i>	Caraguia	Angiosperms	150	3	1	-0.800	0.270				0.793
<i>Carpinus betulus</i>	Carpbetu	Angiosperms	530	5	1	-3.750					23.160
<i>Carya glabra</i>	Caryglab	Angiosperms	47	1	1	-2.100					1.270
<i>Carya tomentosa</i>	Carytome	Angiosperms	645	10	2						324.425
<i>Castanopsis acuminatissima</i>	Castacum	Angiosperms	96	8	1		10.490				45.000
<i>Celtis laevigata</i>	Celtlaev	Angiosperms	745	13	2						13.580
<i>Coprosma quadrifida</i>	Coprquad	Angiosperms	57	4	2						0.600
<i>Cornus florida</i>	Cornflor	Angiosperms	126	1	1	-4.442	0.768				46.343
<i>Cryptocarya laevigata</i>	Cryplaev	Angiosperms	72	6	1		2.140				19.075
<i>Cupania macrophylla</i>	Cupamacr	Angiosperms	40	1	1						
<i>Dicorynia guianensis</i>	Dicoguia	Angiosperms	596	9	2			-1.712			717.500
<i>Drimys brasiliensis</i>	Drimbras	Angiosperms	90	5	1						18.420
<i>Elaeagnus angustifolia</i>	Elaeangu	Angiosperms	402	2	1						11.200
<i>Eschweilera coriacea</i>	Eschcori	Angiosperms	249	4	2						58.654
<i>Eschweilera grandiflora</i>	Eschgran	Angiosperms	378	2	1			-1.754	0.746		62.085
<i>Eschweillera sp.</i>	Eschsp	Angiosperms	40	1	1						
<i>Eucalyptus baxteri</i>	Eucabaxt	Angiosperms	112	4	2						
<i>Eucalyptus camaldulensis</i>	Eucacama	Angiosperms	564	3	1	-4.025	3.600	-2.010	2.364	0.508	10.910
<i>Eucalyptus cypellocarpa</i>	Eucacypte	Angiosperms	29	2	2						
<i>Eucalyptus globulus</i>	Eucaglob	Angiosperms	4555	23	2	-1.100	3.950	-1.640	3.155	0.610	
<i>Eucalyptus nitens</i>	Eucanite	Angiosperms	378	7	1						2.163
<i>Eucalyptus obliqua</i>	Eucaobli	Angiosperms	2466	6	1						
<i>Eucalyptus radiata</i>	Eucaradi	Angiosperms	170	2	1			-1.340			16.790
<i>Eucalyptus rubida</i>	Eucarubi	Angiosperms	2055	5	1		5.560	-1.130	1.222		
<i>Fagus grandifolia</i>	Fagugran	Angiosperms	6815	32	3	-5.080					0.813
<i>Fagus sylvatica</i>	Fagusylv	Angiosperms	15075	93	12	-2.972	1.830	-2.107	3.934		24.030
<i>Fraxinus americana</i>	Fraxamer	Angiosperms	378	2	1	-1.920					339.552
<i>Fraxinus excelsior</i>	Fraxexc	Angiosperms	636	6	1	-2.805		-1.750			0.040
<i>Fraxinus pennsylvanica</i>	Fraxpenn	Angiosperms	178	2	1	-0.777	1.397	-2.360			1.016
<i>Genipa americana</i>	Geniamer	Angiosperms	40	1	1	-1.270	1.500	-2.550			242.210
<i>Gouania glabra</i>	Goupglab	Angiosperms	172	3	3						31.288
<i>Gymnanthes riparia</i>	Gymnripa	Angiosperms	150	3	1						
<i>Hevea brasiliensis</i>	Hevebras	Angiosperms	1302	6	1	-1.859	2.582	-2.650	0.618		
<i>Ilex aquifolium</i>	Ilexaqui	Angiosperms	567	3	1	-4.241	0.186	-2.190	4.825	0.030	16.770
<i>Inga sp.</i>	Ingasp	Angiosperms	40	1	1						

Table D.2: Species resume table. CEP names are Cornell Ecology Programs species names. Ψ_{P50} : water potential at 50% water conductivity loss [MPa], K_s : maximum sapwood water conductivity [$\text{Kg m}^{-1} \text{ MPa}^{-1} \text{ s}^{-1}$], Hv : Huber value [$\text{cm}^2_{\text{Asw}} \text{ m}_{\text{leaf area}}^{-2}$], Ψ_{TLP} : water potential at turgor-loss point [MPa], R_{depth} : rooting depth [m], L_s : individual leaf area [cm^2]. (*continued*)

Species	CEP names	Group	# tree-days	# trees	# plots	Ψ_{P50}	K_s	Ψ_{TLP}	Hv	R_{depth}	L_s
<i>Iryanthera sagotiana</i>	Iryasago	Angiosperms	72	1	1			-1.830			
<i>Juniperus monosperma</i>	Junimono	Gymnosperms	23650	15	3	-8.882	0.710	-3.930	5.700	0.305	0.400
<i>Kandelia obovata</i>	Kandobov	Angiosperms	2584	8	1						
<i>Larix decidua</i>	Larideci	Gymnosperms	3127	23	5	-3.791	0.434	-2.835		1.016	0.170
<i>Larix gmelinii</i>	Larigmel	Gymnosperms	303	3	1						
<i>Larix sibirica</i>	Larisibi	Angiosperms	516	3	1						
<i>Lecythis poiteaui</i>	Lecypoit	Angiosperms	90	2	1			-2.581			
<i>Licania alba</i>	Licaalba	Angiosperms	141	3	1			-2.044	0.664		157.435
<i>Licania membranacea</i>	Licamemb	Angiosperms	217	2	2			-2.239	0.401		38.313
<i>Licania octandra</i>	Licaocta	Angiosperms	256	2	1				1.088		32.005
<i>Licania rodriquesii</i>	Licarodr	Angiosperms	34	1	1						
<i>Liquidambar styraciflua</i>	Liquidsty	Angiosperms	742	23	3	-2.622	1.042		1.949	0.914	47.104
<i>Liriodendron tulipifera</i>	Lirituli	Angiosperms	2246	27	7	-2.390	2.610	-1.130		0.813	116.933
<i>Macrolobium costaricense</i>	Macrcost	Angiosperms	40	1	1						79.840
<i>Malus domestica</i>	Maludome	Angiosperms	1175	5	2			-2.070			16.200
<i>Manilkara bidentata</i>	Manibide	Angiosperms	500	2	1	-2.700	4.333			1.309	0.813
<i>Melioma idiomoda</i>	Melidio	Angiosperms	100	2	1						45.229
<i>Mortoniodendron anisophyllum</i>	Mortanis	Angiosperms	100	2	1						
<i>Myrtaceae sp.</i>	Myrtsp	Angiosperms	72	6	1						
<i>Ostrya virginiana</i>	Ostrvirg	Angiosperms	549	3	2						23.994
<i>Otoba novogranatensis</i>	Otobonovo	Angiosperms	100	2	1						196.140
<i>Oxandra asbeckii</i>	Oxanasbe	Angiosperms	263	3	2						
<i>Palauquium luzoniense</i>	Palaluzo	Angiosperms	72	6	1						
<i>Picea abies</i>	Piceabie	Gymnosperms	11873	109	11	-3.714	0.558	-1.950	7.375	0.711	0.150
<i>Picea sitchensis</i>	Picesitc	Gymnosperms	990	15	1	-3.850				1.500	0.180
<i>Pinus canariensis</i>	Pinucana	Gymnosperms	4890	10	1						
<i>Pinus cembra</i>	Pinucemb	Gymnosperms	1151	14	5	-3.192	0.267	-2.340			
<i>Pinus edulis</i>	Pinuedul	Gymnosperms	23715	15	3	-4.718		-1.990		0.508	1.250
<i>Pinus halepensis</i>	Pinuhale	Gymnosperms	1329	3	1	-4.105	0.335	-3.000	7.590		
<i>Pinus nigra</i>	Pinunigr	Gymnosperms	11246	15	3	-3.753	0.407	-1.800	7.860	1.016	1.110
<i>Pinus patula</i>	Pinupatu	Gymnosperms	152	8	1						
<i>Pinus pinaster</i>	Pinupina	Gymnosperms	2130	10	1	-3.489	0.352		9.870		
<i>Pinus resinosa</i>	Pinuresi	Gymnosperms	1176	42	1			-1.940		1.016	4.400
<i>Pinus rigida</i>	Pinurigi	Gymnosperms	489	2	2						3.150
<i>Pinus sibirica</i>	Pinusibi	Gymnosperms	516	3	1						
<i>Pinus strobus</i>	Pinustro	Gymnosperms	32538	60	4						2.700
<i>Pinus sylvestris</i>	Pinusylv	Gymnosperms	42463	215	21	-3.163	0.448	-1.975	6.257	0.508	0.947
<i>Pinus taeda</i>	Pinutaed	Gymnosperms	24380	97	4	-2.810	1.197		4.848	0.889	
<i>Platea excelsa</i>	Platexce	Angiosperms	72	6	1						
<i>Pleuranthonodendron lindenii</i>	Pleulind	Angiosperms	40	1	1						53.633
<i>Populus canescens</i>	Popucane	Angiosperms	597	3	1						
<i>Populus euphratica</i>	Popueuph	Angiosperms	841	9	3	-2.264	2.998	-2.900	2.420		
<i>Populus grandidentata</i>	Popugran	Angiosperms	6888	12	1						42.608
<i>Populus tremuloides</i>	Poputrem	Angiosperms	4455	99	1	-1.876	0.934		1.910	1.000	24.690
<i>Pouteria anomala</i>	Poutanom	Angiosperms	912	3	1					1.392	42.295
<i>Pouteria firma</i>	Poutfirm	Angiosperms	72	6	1						
<i>Pouteria sp.</i>	Poutsp	Angiosperms	40	1	1						
<i>Pouteria viridis</i>	Poutviri	Angiosperms	100	2	1						
<i>Protium tenuifolium</i>	Prottenu	Angiosperms	242	2	1				1.587		413.810
<i>Prunus serotina</i>	Prunsero	Angiosperms	100	1	1	-4.270	0.550	-1.420		0.914	24.759
<i>Pseudotsuga menziesii</i>	Pseumenz	Gymnosperms	2985	18	3	-3.926	1.366	-2.970	4.153	0.660	0.280
<i>Qualea rosea</i>	Qualrose	Angiosperms	141	3	1			-1.779			
<i>Qualea tricolor</i>	Qualtric	Angiosperms	78	2	1						
<i>Quercus alba</i>	Queralba	Angiosperms	1094	9	5	-1.818	4.877	-2.050	1.454	1.219	54.302

D.3. Tables D

Table D.2: Species resume table. CEP names are Cornell Ecology Programs species names. Ψ_{P50} : water potential at 50% water conductivity loss [MPa], K_s : maximum sapwood water conductivity [$\text{Kg m}^{-1} \text{ MPa}^{-1} \text{ s}^{-1}$], H_v : Huber value [$\text{cm}^2_{\text{Asw}} \text{ m}_{\text{leaf area}}^{-2}$], Ψ_{TLP} : water potential at turgor-loss point [MPa], R_{depth} : rooting depth [m], L_s : individual leaf area [cm^2]. (*continued*)

Species	CEP names	Group	# tree-days	# trees	# plots	Ψ_{P50}	K_s	Ψ_{TLP}	H_v	R_{depth}	V_s
<i>Quercus cerris</i>	Quercerr	Angiosperms	284	2	1		-3.580			29.190	
<i>Quercus coccinea</i>	Quercocc	Angiosperms	5343	11	3					121.678	
<i>Quercus faginea</i>	Querfagi	Angiosperms	6784	10	2	-2.002		-3.160		4.210	
<i>Quercus falcata</i>	Querfalc	Angiosperms	134	1	1	-0.893	2.323		2.057	41.635	
<i>Quercus ilex</i>	Querilex	Angiosperms	65295	62	6	-3.438	1.595	-3.015	3.980	8.078	
<i>Quercus lyrata</i>	Querlyra	Angiosperms	745	13	2						
<i>Quercus michauxii</i>	Quermich	Angiosperms	132	4	1	-1.700				71.498	
<i>Quercus montana</i>	Quermont	Angiosperms	5488	14	2						
<i>Quercus petraea</i>	Querpetr	Angiosperms	4617	29	5	-3.294		-2.624		0.300	35.000
<i>Quercus phellos</i>	Querphel	Angiosperms	185	5	1	-1.375	3.787		1.806		8.935
<i>Quercus prinus</i>	Querprin	Angiosperms	316	2	1	-1.700					
<i>Quercus pubescens</i>	Querpube	Angiosperms	6505	19	2	-2.696	1.612	-3.515	0.782		32.200
<i>Quercus pyrenaica</i>	Querpyre	Angiosperms	6680	32	2			-2.680			30.260
<i>Quercus robur</i>	Querrobu	Angiosperms	636	6	1	-2.802		-2.583		0.300	46.537
<i>Quercus rotundifolia</i>	Querrrotu	Angiosperms	4796	10	2						3.460
<i>Quercus rubra</i>	Querrubr	Angiosperms	15185	32	6	-2.237	1.602	-2.725	1.746	0.914	66.641
<i>Quercus suber</i>	Quersuber	Angiosperms	1816	4	1	-5.200		-3.080			7.030
<i>Quercus velutina</i>	Querveluv	Angiosperms	5132	16	3			-2.750		1.016	110.450
<i>Recordoxylon speciosum</i>	Recospec	Angiosperms	41	1	1						
<i>Santiria apiculata</i>	Santapic	Angiosperms	55	5	1						
<i>Sassafras albidum</i>	Sassalbi	Angiosperms	117	1	1						68.080
<i>Sextonia rubra</i>	Sextruber	Angiosperms	34	1	1						74.000
<i>Sloanea sp</i>	Sloasp	Angiosperms	156	2	2						
<i>Swartzia racemosa</i>	Swarrace	Angiosperms	476	2	1			1.156			246.450
<i>Taxus baccata</i>	Taxubacc	Gymnosperms	922	2	1	-7.360	0.320		1.900	0.406	0.500
<i>Thuja occidentalis</i>	Thujocci	Gymnosperms	340	10	1	-3.570				0.762	0.100
<i>Tilia americana</i>	Tiliamer	Angiosperms	72	1	1						130.715
<i>Trophis mexicana</i>	Tropmexi	Angiosperms	40	1	1						13.880
<i>Tsuga canadensis</i>	Tsugcana	Gymnosperms	5739	24	2	-3.070	0.329		3.362	0.711	0.480
<i>Ulmus americana</i>	Ulmuamer	Angiosperms	133	1	1						56.993
<i>Vantanea sp</i>	Vantsp	Angiosperms	69	1	1						
<i>Vernonia arborea</i>	Vernarbo	Angiosperms	36	3	1		2.110		2.060		
<i>Vouacapoua americana</i>	Vouaamer	Angiosperms	178	3	3			-2.147	0.744		353.583

Table D.3: Results of the linear models relating water use parameters calculated using G'_{Asw} to water relations traits. Parameters are explained by individual traits using simple linear models with number of species-days as weighting factor.

Parameter	Trait	N Species	Intercept	Slope	R^2
G'_{REF}	$\ln(\Psi_{P50})$	25	333.019 ***	-111.725 **	0.331
	$\ln(K_s)$	19	196.081 ***	81.935 **	0.359
	$\ln(Hv)$	20	297.029 ***	-71.225 *	0.188
	$ \Psi_{\text{TLP}} $	25	196.754 **	-4.398	0.000
	R_{depth}	13	-13.266	303.191 **	0.508
	$\ln(L_s)$	26	151.531 ***	31.494 ***	0.497
β'_{VPD}	$\ln(\Psi_{P50})$	25	235.774 ***	-95.494 *	0.215
	$\ln(K_s)$	19	125.553 ***	95.013 **	0.448
	$\ln(Hv)$	20	221.274 ***	-69.362 *	0.153
	$ \Psi_{\text{TLP}} $	25	62.062	17.932	0.000
	R_{depth}	13	-74.639 *	245.287 ***	0.681
	$\ln(L_s)$	26	69.367 ***	31.574 ***	0.409
β'_{SWC}	$\ln(\Psi_{P50})$	25	34.052 .	21.703	0.066
	$\ln(K_s)$	19	57.145 ***	-19.246 .	0.111
	$\ln(Hv)$	20	39.018 .	13.555	0.008
	$ \Psi_{\text{TLP}} $	25	86.217 ***	-9.086	0.011
	R_{depth}	13	94.44 ***	-29.023	0.038
	$\ln(L_s)$	26	73.395 ***	-8.696 **	0.234

Statistical significant levels: ., $P < 0.1$; *, $P < 0.05$; **, $P < 0.01$; ***, $P < 0.001$.

Table D.4: Results of the linear models relating water use parameters to water relations traits using REW instead of SWC. Parameters are explained by individual traits using simple linear models with number of species-days as weighting factor.

Parameter	Trait	N Species	Intercept	Slope	R^2
G_{REF}	$\ln(\Psi_{P50})$	55	198.741 ***	-70.836 ***	0.328
	$\ln(K_s)$	43	112.403 ***	37.208 ***	0.375
	$\ln(Hv)$	49	177.173 ***	-45.734 ***	0.389
	$ \Psi_{TLP} $	48	171.577 ***	-24.124 **	0.118
	R_{depth}	37	28.834	122.446 ***	0.373
	$\ln(L_s)$	86	86.92 ***	17.171 ***	0.488
β_{VPD}	$\ln(\Psi_{P50})$	55	109.036 ***	-48.046 ***	0.240
	$\ln(K_s)$	43	49.473 ***	20.603 **	0.181
	$\ln(Hv)$	49	96.583 ***	-34.355 ***	0.369
	$ \Psi_{TLP} $	48	79.314 ***	-12.005	0.037
	R_{depth}	37	-1.771	79.374 ***	0.252
	$\ln(L_s)$	86	33.569 ***	11.392 ***	0.336
β_{REW}	$\ln(\Psi_{P50})$	55	13.956 **	-3	0.000
	$\ln(K_s)$	43	11.426 ***	1.256	0.000
	$\ln(Hv)$	49	11.166 ***	0.339	0.000
	$ \Psi_{TLP} $	48	18.869 ***	-3.274 .	0.054
	R_{depth}	37	5.99	5.114	0.000
	$\ln(L_s)$	86	15.63 ***	-0.373	0.000

Statistical significant levels: ., $P < 0.1$; *, $P < 0.05$; **, $P < 0.01$; ***, $P < 0.001$.

Table D.5: Results of the linear models relating water use parameters calculated using G'_{Asw} , water relations traits, climate and tree height. Water use parameters are explained by individual traits, MAP (mean annual precipitation) and H (tree height) using simple linear models using number of species-days as weighting factor. β values are the slopes for each explanatory variable. NI = not included variable after model selection.

Parameter	Trait	N Species	Intercept	β_{trait}	β_{MAP}	β_H	R^2
G'_{REF}	$\ln(\Psi_{P50})$	25	328.177 ***	-106.498 **	NI	NI	0.262
	$\ln(K_s)$	19	199.257 ***	74.161 **	NI	NI	0.317
	$\ln(Hv)$	20	296.21 ***	-68.395 *	NI	NI	0.177
	$ \Psi_{TLP} $	25	72.695	NI	0.175 **	NI	0.240
	R_{depth}	13	0.75	280.314 **	NI	NI	0.468
	$\ln(L_s)$	26	158.682 ***	28.552 ***	NI	NI	0.435
β'_{VPD}	$\ln(\Psi_{P50})$	25	-10.852	NI	0.274 ***	-5.198 **	0.476
	$\ln(K_s)$	19	71.809	60.751 *	0.153 .	-4.342 .	0.539
	$\ln(Hv)$	20	149.585 .	-54.146 .	0.177 *	-6.093 *	0.432
	$ \Psi_{TLP} $	25	-17.511	NI	0.29 ***	-5.639 **	0.522
	R_{depth}	13	-63.756 .	226.165 ***	NI	NI	0.630
	$\ln(L_s)$	26	23.708	23.07 **	0.182 **	-5.54 ***	0.615
β'_{SWC}	$\ln(\Psi_{P50})$	25	95.16 ***	NI	-0.084 **	1.953 **	0.366
	$\ln(K_s)$	19	84.858 ***	NI	-0.072 *	1.91 *	0.261
	$\ln(Hv)$	20	78.013 **	NI	-0.06 *	1.809 .	0.191
	$ \Psi_{TLP} $	25	98.488 ***	NI	-0.089 ***	1.91 *	0.388
	R_{depth}	13	92.124 ***	NI	NI	-1.025 .	0.173
	$\ln(L_s)$	26	90.501 ***	-5.107	-0.066 *	2.011 **	0.402

Statistical significant levels: ., $P < 0.1$; *, $P < 0.05$; **, $P < 0.01$; ***, $P < 0.001$.

References

Placeholder