Supplement of Geosci. Model Dev., 8, 2035–2065, 2015
http://www.geosci-model-dev.net/8/2035/2015/
doi:10.5194/gmd-8-2035-2015-supplement

Geoscientific Model Development
Open Access

Supplement of

A vertically discretised canopy description for ORCHIDEE (SVN r2290) and the modifications to the energy, water and carbon fluxes

K. Naudts et al.

Correspondence to: K. Naudts (kim.naudts@lsce.ipsl.fr)

1 Supplementary information

This document contains the supplementary figures and tables of the manuscript ’A vertically discretised canopy description for ORCHIDEE (SVN r2290) and the modifications to the energy, water and carbon fluxes’.

1.1 Figures

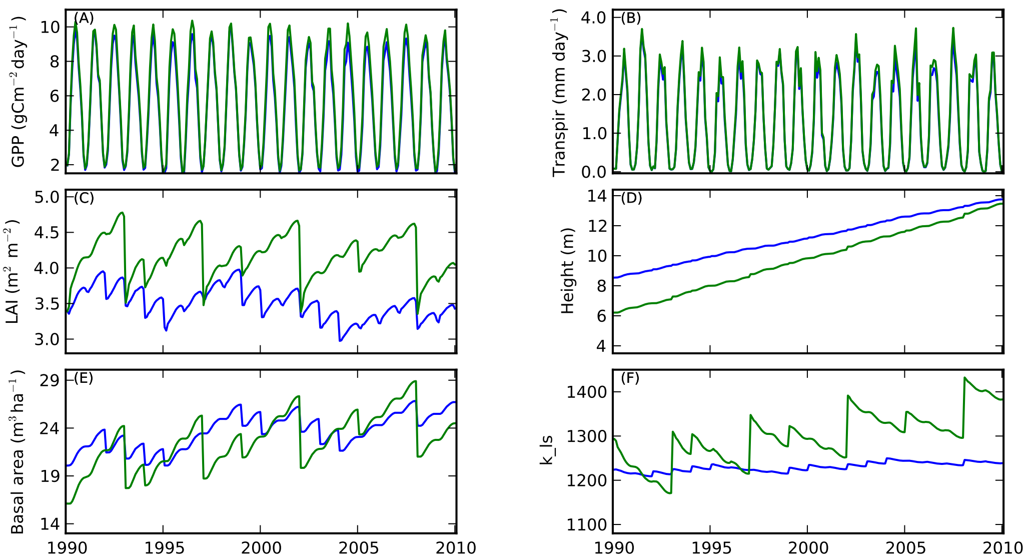

Figure S1. Impact of the optimization of k_{cmaint} and k_{lsmin} for an unmanaged Scots pine forest at $51-52\,^{\circ}$N, $13-14\,^{\circ}$E for GPP (A), transpiration (B), LAI (C), tree height (D), basal area (E) and the ratio of leaf area to sapwood area (F). The simulation with prior parameter values is shown in green (k_{cmaint}= 0.01 and $k_{lsmin,max} = 850-2000$) and the simulation with optimized values is presented in blue (k_{cmaint}= 0.033 and $k_{lsmin,max} = 1100-1395$).

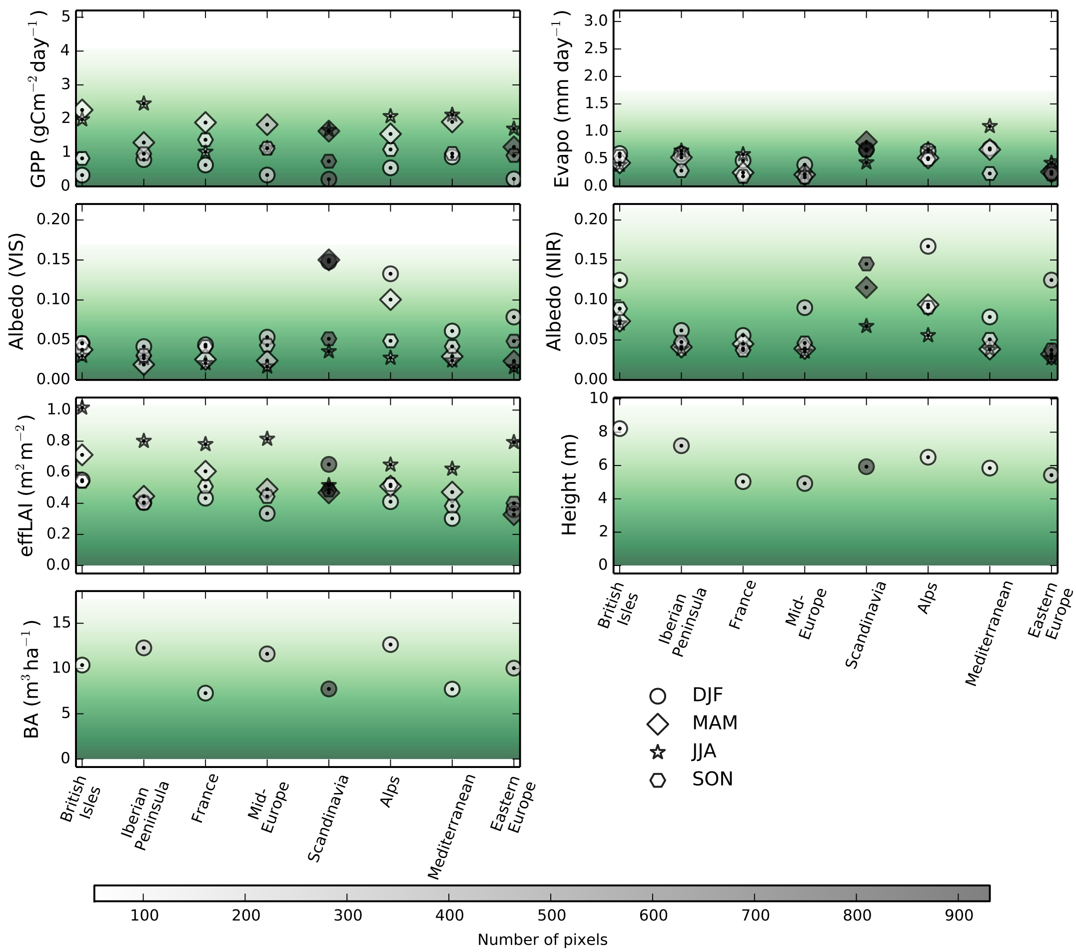

Figure S2. Root mean square error of an ORCHIDEE-CAN simulation with metaclass parameters. Results are shown for gross primary production, evapotranspiration, visible and near-infra-red albedo, effective leaf area index, basal area and height for different regions and periods (DJF: December-February, MAM: March-May, JJA: June-August, SON: September-November). The gray-scale of the symbols indicates the number of pixels included in the calculation. The transition from green to white indicates an RMSE of 100%.

1.2 Tables

Table S1. Description of the parameters in ORCHIDEE-CAN

Symbol in text	Unit	Value	Symbol in ORCHIDEE-CAN	Description	References
k_{cmaint}	-	Table S2	coeff_maint_init	Fraction of allocatable photosynthates that is consumed for maintenance and growth respiration	Ryan (1991)
k_{ls},k_{lsmin}, k_{lsmax}	m	Table S2	k_latosa, k_latosa_min, k_latosa_max	Leaf area to sapwood area of an individual tree	Pothier and Margolis (1991); Bartelink (1997); Berthier et al. (2001); Mencuccini and Bonosi (2001); Wullschleger et al. (1998); Novick et al. (2009); Schäfer et al. (2000); Samuelson et al. (2007); Gould and Harrington (2008); McDowell et al. (2002); Meadows and Hodges (2002); David et al. (2004); Limousin et al. (2012); Bréda and Granier (1996); Martin et al. (1998); Vincke et al. (2005); Margolis et al. (1995)
k_{sar}	-	eq. 7	c0_alloc	Sapwood mass to root mass for an individual tree	Calculated from other parameters
k_{Vcmax}	μmol m^{-2}s^{-1}	Table S3	Vcmax25	Carboxylation capacity	TRY
$k_{Jmax/Vcmax}$	μmol e^{-}(μmol CO_2)$^{-1}$	Table S3	arjv	Ratio of electron transport capacity to carboxylation capacity	TRY
k_{sla}	m^2 gC^{-1}	Table S3	sla	Specific leaf mass	TRY
$k_{\rho s}$	gC m^{-3}	Table S3	pipe_density	Carbon density of sapwood	TRY; Gaspar et al. (2008); Repola (2006); Knapic et al. (2008); Jenkins et al. (2003)
$k_{\tau l}$	days	Table S3	tau_leaf	Leaf longevity	ICP forest, TRY
$k_{\tau s}$	days	Table S3	tau_sap	Sapwood longevity	Björklund (1999); Longuetaud et al. (2006); Gebauer et al. (2008); Schulze et al. (1995)

Table S1. Continuation of Table S1.

Symbol in text	Unit	Value	Symbol in ORCHIDEE-CAN	Description	References
$k_{\tau r}$	days	Table S3	tau_root	Root longevity	Brunner et al. (2013)
k_{ap}	m	Table S3	pipe_tune1	Parameter in the relationship between diameter and projected crown surface area	Pretzsch and Dieler (2012)
k_{bp}	-	Table S3	pipe_tune_exp_coeff	Parameter in the relationship between diameter and projected crown surface area	Pretzsch and Dieler (2012)
k_{ncirc}	-	3	ncirc	Number of circumference classes	Assumed
k_{α}, $k_{\alpha'}$	n.a.	n.a.	n.a.	Generic parameter to develop equation 40	n.a.
k_{β}	n.a.	n.a.	n.a.	Generic parameter to develop equation 40	n.a.
$k_{\alpha 1}$	m^{-1}	Table S3	pipe_tune2	Allometric constant relating tree diameter and height	Swedish, German, French and Spanish NFI
$k_{\beta 1}$	-	Table S3	pipe_tune3	Allometric constant relating tree diameter and height	Swedish, German, French and Spanish NFI
$k_{\alpha 2}$	-	Table S3	alpha_self_thinning	Allometric constant of the self-thinning relationship	Swedish, German, French and Spanish NFI
$k_{\beta 2}$	-	Table S3	beta_self_thinning	Allometric constant of the self-thinning relationship	Swedish, German, French and Spanish NFI
k_{m}	-	1	m	Relaxation constant of intra-specific competition relationship	Assumed
k_{ddf}	-	1	death_df	Factor by which the smallest and largest circumference classes differ	Assumed
$k_{t_{resid}}$	years	Table S3	residence_time	Residence time of tree, accounting for mortality due to pest, diseases and windfall	Assumed

Table S1. Continuation of Table S1.

Symbol in text	Unit	Value	Symbol in ORCHIDEE-CAN	Description	References
k_{lcon}	m s^{-1} MPa^{-1}	Table S3	k_leaf	Hydraulic conductivity of leaves	Hickler et al. (2006); Sellin et al. (2013); Aranda et al. (2005) ;
k_{scon}	m^2 s^{-1} MPa^{-1}	Table S3	k_sap	Hydraulic conductivity of sapwood	Manzoni et al. (2013); Cochard (1992): Magnani et al. (2000); Quero et al. (2011);Sellin et al. (2013)
k_{rcon}	m^3 kg^{-1} s^{-1} MPa^{-1}	Table S3	k_root	Hydraulic conductivity of roots	Magnani et al. (2000);Steudle (2000); Arneth et al. (1996)
$k_{\psi 50}$	MPa	Table S3	psi_50	Soil water potential that causes 50% loss of xlem conductivit through cavitation	Choat et al. (2012); Manzoni et al. (2013); Corcuera et al. (2004); Fichot et al. (2010, 2011); Hickler et al. (2006); Cochard (1992)
$k_{\psi lmin}$	MPa	Table S3	psi_leaf	Minimal leaf water potenial	Choat et al. (2012); Martinez-Vilalta et al. (2004); Magnani et al. (2000); Limousin et al. (2012)l; Hacke and Sauter (1995); Sellin et al. (2013); Schulze et al. (1985)
k_c	-	3	c_cavitation	Shape parameter for vulnerability curve for cavitation	Hickler et al. (2006)
$k_{\alpha 1v}$	-	0.556	a_viscosity(1)	Empirical parameter for the temperature dependence of hydraulic resistance	Cochard et al. (2000)
$k_{\alpha 2v}$	-	0.022	a_viscosity(2)	Empirical parameter for the temperature dependence of hydraulic resistance	Cochard et al. (2000)
$k_{\lambda,LE}$	J kg^{-1}		chalev0	Latent heat of evaporation	
$k_{\rho a,i}$	kg m^{-3}		rau	Air density, calculated from air temperature and pressure	
$k_{\rho v,i}$	kg m^{-3}	1000	rho_veg	Leaf density, assumed to be equal to the heat capacity of water	

Table S1. Continuation of Table S1. Soil parameters are given for each soil tile: BS, bare soil, GC: grasses and crops, T:trees

Symbol in text	Unit	Value	Symbol in ORCHIDEE-CAN	Description	References
$k_{lhc,i}$	J kg K^{-1}	4.18 10^{-3}	jtheta	Leaf layer heat capacity	
$k_{\rho w}$	g cm^{-3}		rho_h2o	Density of water at 15° C	
k_g	m s^{-2}		cte_grav	Gravitational constant	
$k_{k,i}$	m^2 s^{-1}		k_eddy	Diffusivity coefficient	
k_{av}	m^{-1}	0.0075 (BS) 0.0036 (GC) 0.0019 (T)	avan_fao	Van Genuchten (1980) coefficient α	Carsel and Parrish (1988)
k_{swcs}	m^3 m^{-3}	0.41 (BS) 0.43 (GC) 0.41 (T)	mcs_fao	Saturated soil water content	Carsel and Parrish (1988)
k_{swcr}	m^3 m^{-3}	0.065 (BS) 0.078 (GC) 0.095 (T)	mcr_fao	Residual soil water content	Carsel and Parrish (1988)
k_{mv}	-	Calculated from n	-	Van Genuchten (1980) coefficient m	Carsel and Parrish (1988)
k_{nv}	-	1.89 (BS) 1.56 (GC) 1.31 (T)	nvan_fao	Van Genuchten (1980) coefficient n	Carsel and Parrish (1988)
Leaf$^{vis}_{ssa}$	-	Table S4	leaf_ssa_vis	Leaf single scattering albedo, visible light	Derived from Pinty et al. (2007)
Leaf$^{nir}_{ssa}$	-	Table S4	leaf_ssa_nir	leaf single scattering albedo, near infrared	Derived from Pinty et al. (2007)
Leaf$^{vis}_{psd}$	-	Table S4	leaf_psd_vis	Leaf preferred scattering direction, visible light	Derived from Pinty et al. (2007)
Leaf$^{nir}_{psd}$	-	Table S4	leaf_psd_nir	Leaf preferred scattering direction, near infrared	Derived from Pinty et al. (2007)
Bgrd$^{vis}_{ref}$	-	Table S4	bgd_reflectance_vis	Background reflectance, visible light	Derived from Pinty et al. (2007)
Bgrd$^{vis}_{ref}$	-	Table S4	bgd_reflectance_nir	Background reflectance, near infrared	Derived from Pinty et al. (2007)

Table S2. Parameter values per species group for allocation and mortality. Te, Temperate; Bo, Boreal; Ne, Needleleaf; Br, Broadleaved; E, Evergreen; S, Summergreen.

MTC	**Species (PFT)**	k_{cmaint}	k_{lsmin}	k_{lsmax}	k_{ap}	k_{bp}	$k_{\tau l}$	$k_{\tau s}$	$k_{\tau r}$	$k_{\rho s}$	$k_{\alpha 1}$	$k_{\beta 1}$	$k_{\alpha 2}$	$k_{\beta 2}$	$k_{t_{resid}}$
TeNeE	*Pinus sylvestris*	0.0330	1100	1395	97	1.47	720	13870	224	200000	33	0.63	1236	-0.57	250
TeNeE	*Pinus pinaster*	0.0175	250	1745	54	1.05	1670	15148	275	235000	29	0.53	1626	-0.59	250
TeNeE	*Picea sp.*	0.0379	1350	3900	113	0.85	1460	16425	326	190000	35	0.54	1507	-0.59	250
TeBrE	*Quercus ilex/suber*	0.0291	675	3079	146	1.52	677	11680	191	480000	14	0.33	1678	-0.64	250
TeBrS	*Betula sp.*	0.0097	2600	3600	91	1.16	146	11680	280	238000	35	0.66	1272	-0.61	200
TeBrS	*Fagus sylvatica*	0.0130	2700	4430	173	1.70	183	11680	280	334000	32	0.52	1000	-0.60	200
TeBrS	*Quercus robur/petraea*	0.0021	3300	4380	173	1.70	183	11680	280	300000	32	0.52	1100	-0.60	200
TeBrS	*Populus sp.*	0.0160	5000	5100	139	1.40	183	11680	280	176000	39	0.50	1407	-0.60	200
BoNeE	*Pinus sylvestris*	0.0346	2600	4300	70	1.49	1160	11680	224	200000	41	0.59	991	-0.58	350
BoNeE	*Picea sp.*	0.0467	2500	3000	40	1.11	2160	11680	368	190000	45	0.57	1166	-0.58	350
BoBrS	*Betula sp.*	0.0767	4800	5000	77	1.21	146	11680	280	238000	41	0.66	1272	-0.60	150
BoNeS	*Larix sp.*	0.1100	5000	6000	83	1.40	180	13870	360	248750	30	0.52	1426	-0.60	350

Table S3. Parameter values per species group for hydraulic architecture and photosynthesis. Te, Temperate; Bo, Boreal; Ne, Needleleaf; Br, Broadleaved; E, Evergreen; S, Summergreen.

MTC	**Species (PFT)**	k_{lcon}	k_{scon}	k_{rcon}	$k_{\psi 50}$	$k_{\psi lmin}$	k_{Vcmax}	$k_{Jmax/Vcmax}$	k_{sla}
TeNeE	*Pinus sylvestris*	$1.50\,10^{-7}$	$8.50\,10^{-4}$	$2.30\,10^{-7}$	-3.36	-1.60	87	2.48	0.0114
TeNeE	*Pinus pinaster*	$1.50\,10^{-7}$	$3.52\,10^{-4}$	$3.30\,10^{-7}$	-3.22	-2.30	90	1.72	0.005
TeNeE	*Picea sp.*	$1.50\,10^{-7}$	$4.00\,10^{-4}$	$4.29\,10^{-7}$	-3.98	-1.95	61	1.91	0.0072
TeBrE	*Quercus ilex/suber*	$1.50\,10^{-7}$	$1.08\,10^{-4}$	$2.56\,10^{-6}$	-3.83	-4.48	39	2.22	0.0137
TeBrS	*Betula sp.*	$3.50\,10^{-7}$	$3.00\,10^{-3}$	$2.51\,10^{-7}$	-2.40	-0.94	77	2.18	0.0288
TeBrS	*Fagus sylvatica*	$3.50\,10^{-7}$	$3.60\,10^{-4}$	$2.01\,10^{-7}$	-3.98	-2.15	40	2.08	0.0330
TeBrS	*Quercus robur/petraea*	$3.50\,10^{-7}$	$1.03\,10^{-3}$	$3.02\,10^{-7}$	-3.23	-2.94	65	2.04	0.0286
TeBrS	*Populus sp.*	$3.50\,10^{-7}$	$1.46\,10^{-3}$	$2.51\,10^{-7}$	-2.00	-1.62	137	1.40	0.0256
BoNeE	*Pinus sylvestris*	$1.50\,10^{-7}$	$8.50\,10^{-4}$	$2.30\,10^{-7}$	-2.40	-1.60	50	2.48	0.008
BoNeE	*Picea sp.*	$1.50\,10^{-7}$	$4.00\,10^{-4}$	$2.45\,10^{-7}$	-3.20	-1.95	87	2.09	0.0066
BoBrS	*Betula sp.*	$3.52\,10^{-7}$	$3.00\,10^{-3}$	$2.51\,10^{-7}$	-3.15	-0.94	77	2.18	0.0288
BoNeS	*Larix sp.*	$2.50\,10^{-7}$	$5.82\,10^{-4}$	$3.00\,10^{-7}$	-3.66	-1.60	40	2.00	0.0218

Table S4. Parameter values per species group for radiation transfer and photosynthesis. Te, Temperate; Bo, Boreal; Ne, Needleleaf; Br, Broadleaved; E, Evergreen; S, Summergreen.

MTC	Species (PFT)	Leaf_ssa_vis	Leaf_ssa_nir	Leaf_psd_vis	Leaf_psd_nir	Bgrd_ref_vis	Bgrd_ref_nir
TeNeE	*Pinus sylvestris*	0.1529	0.74131	1.0400	2.1160	0.056095	0.098511
TeNeE	*Pinus pinaster*	0.1703	0.78242	1.0946	2.2343	0.058601	0.098511
TeNeE	*Picea sp.*	0.1504	0.74644	1.0395	2.1346	0.042981	0.073559
TeBrE	*Quercus ilex/suber*	0.1343	0.73407	1.0255	2.0953	0.055900	0.095732
TeBrS	*Betula sp.*	0.1722	0.72176	1.0359	2.0575	0.088728	0.14427
TeBrS	*Fagus sylvatica*	0.1415	0.76699	1.0711	2.1959	0.051854	0.089514
TeBrS	*Quercus robur/petraea*	0.1562	0.74554	1.0433	2.1163	0.100240	0.17743
TeBrS	*Populus sp.*	0.1395	0.72523	1.0214	2.0733	0.057965	0.093873
BoNeE	*Pinus sylvestris*	0.1529	0.74131	1.0400	2.1160	0.056095	0.093891
BoNeE	*Picea sp.*	0.1504	0.74644	1.0359	2.1346	0.042981	0.073559
BoBrS	*Betula sp.*	0.1722	0.72176	1.1753	2.0575	0.088728	0.14427
BoNeS	*Larix sp.*	0.1512	0.84980	1.1753	2.4347	0.051740	0.08372

Table S5. Description of the forest management strategies in ORCHIDEE-CAN. For the ease of presentation the Relative Density Index was calculated for a stand with 750 trees ha^{-1} based on the species specific parameters for alpha_rdi_upper, beta_rdi_upper, alpha_rdi_lower, beta_rdi_lower. First thinning height is the height that needs to be reached by at least 100 trees before thinning occurs.

Parameter	**Units**	**ORCHIDEE-CAN**	**Unmanaged**	**High stand**	**Coppice**	**SRC**
Initial density	tree ha^{-1}	nmaxtrees	6,000 – 15,000	6,000 – 15,000	6,000 – 15,000	6,000 – 15,000
Initial height	m	height_init_min	2 – 3	2 – 3	2 – 3	2 – 3
	m	height_init_max	3 – 4	3 – 4	3 – 4	3 – 4
Self-thinning	tree m^{-2}	alpha_self_thinning	991 – 1678	991 – 1678	991 – 1678	991 – 1678
	-	beta_self_thinning	-0.57 – -0.64	-0.57 – -0.64	-0.57 – -0.64	-0.57 – -0.64
Longevity	year	residence_time	200 – 350	200 – 350	200 – 350	200 – 350
First thinning height	m	h_first	n.a.	6 – 8	n.a.	n.a.
Relative density index	-	n.a.	n.a.	0.6 – 0.9	n.a.	n.a.
Stand replacing density	tree ha^{-1}	ntrees_dia_profit	100	100	n.a.	n.a.
Harvest diameter	m	largest_tree_dia	n.a.	0.2 – 0.6	n.a.	n.a.
Coppice diameter	m	coppice_diameter	n.a.	n.a.	0.2	n.a.
Rotation length	year	src_rot_length	n.a.	n.a.	n.a.	3
Number of rotations	-	src_nrots	n.a.	n.a.	n.a.	10
Fuelwood diameter	m	fuelwood_diameter	n.a.	0.2 – 0.3	0.2 –0.3	0.2– 0.3

References

Aranda, I., Gil, L., and Pardos, J.: Seasonal changes in apparent hydraulic conductance and their implications for water use of European beech (Fagus sylvatica L.) and sessile oak [Quercus petraea (Matt.) Liebl] in South Europe, Plant Ecology, 179, 155–167, doi:10.1007/s11258-004-7007-1, http://link.springer.com/10.1007/s11258-004-7007-1, 2005.

Arneth, A., Kelliher, F. M., Bauer, G., Hollinger, D. Y., Byers, J. N., Hunt, J. E., Seveny, T. M. M. C., Ziegler, W., Vygodskaya, N. N., Milukova, I., Sogachov, A., Varlagin, A., and Schulze, E.-D.: Environmental regulation of xylem sap flow and total conductance of Larix gmelinii trees in eastern Siberia, Tree physiology, 16, 247–255, 1996.

Bartelink, H. H.: Allometric relationships for biomass and leaf area of beech (Fagus sylvatica L), Annals of Forest Science, 54, 39–50, 1997.

Berthier, S., Kokutse, A., Stokes, A., and Fourcaud, T.: Irregular Heartwood Formation in Maritime Pine (Pinus pinaster Ait): Consequences for Biomechanical and Hydraulic Tree Functioning, Annals of Botany, 87, 19–25, doi:10.1006/anbo.2000.1290, http://aob.oxfordjournals.org/cgi/doi/10.1006/anbo.2000.1290, 2001.

Björklund, L.: Identifying Heartwood-rich Stands or Stems of Pinus sylvestris by Using Inventory Data, Silva Fennica, 33, 119–129, 1999.

Bréda, N. and Granier, A.: Intra- and interannual variations of transpiration, leaf area index and radial growth of a sessile oak stand (Quercus petraea), Annals of Forest Science, 53, 521–536, 1996.

Brunner, I., Bakker, M. R., Björk, R. G., Hirano, Y., Lukac, M., Aranda, X., Bø rja, I., Eldhuset, T. D., Helmisaari, H. S., Jourdan, C., Konôpka, B., López, B. C., Miguel Pérez, C., Persson, H., and Ostonen, I.: Fine-root turnover rates of European forests revisited: an analysis of data from sequential coring and ingrowth cores, Plant and Soil, 362, 357–372, doi:10.1007/s11104-012-1313-5, http://link.springer.com/10.1007/s11104-012-1313-5, 2013.

Carsel, R. F. and Parrish, R. S.: Developing joint probability distributions of soil water retention characteristics, Water Resources Research, 24, 755–769, doi:10.1029/WR024i005p00755, http://doi.wiley.com/10.1029/WR024i005p00755, 1988.

Choat, B., Jansen, S., Brodribb, T. J., Cochard, H., Delzon, S., Bhaskar, R., Bucci, S. J., Feild, T. S., Gleason, S. M., Hacke, U. G., Jacobsen, A. L., Lens, F., Maherali, H., Martínez-Vilalta, J., Mayr, S., Mencuccini, M., Mitchell, P. J., Nardini, A., Pittermann, J., Pratt, R. B., Sperry, J. S., Westoby, M., Wright, I. J., and Zanne, A. E.: Global convergence in the vulnerability of forests to drought., Nature, 491, 752–5, doi:10.1038/nature11688, http://www.ncbi.nlm.nih.gov/pubmed/23172141, 2012.

Cochard, H.: Vulnerability of several conifers to air embolism, Tree Physiology, 11, 73–83, doi:10.1093/treephys/11.1.73, http://treephys.oxfordjournals.org/cgi/doi/10.1093/treephys/11.1.73, 1992.

Cochard, H., Martin, R., Gross, P., and Bogeat-Triboulot, M.: Temperature effects on hydraulic conductance and water relations of Quercus robur L ., Journal of Experimental Botany, 51, 1255–1259, 2000.

Corcuera, L., Camarero, J. J., and Gil-Pelegrin, E.: Effects of a severe drought on Quercus ilex radial growth and xylem anatomy, Trees - Structure and Function, 18, 83–92, doi:10.1007/s00468-003-0284-9, http://link.springer.com/10.1007/s00468-003-0284-9, 2004.

David, T., Ferreira, M., Cohen, S., Pereira, J., and David, J.: Constraints on transpiration from an evergreen oak tree in southern Portugal, Agricultural and Forest Meteorology, 122, 193–

205, doi:10.1016/j.agrformet.2003.09.014, http://linkinghub.elsevier.com/retrieve/pii/S0168192303002351, 2004.

Fichot, R., Barigah, T. S., Chamaillard, S., LE Thiec, D., Laurans, F., Cochard, H., and Brignolas, F.: Common trade-offs between xylem resistance to cavitation and other physiological traits do not hold among unrelated Populus deltoides x Populus nigra hybrids, Plant, cell & environment, 33, 1553–68, doi:10.1111/j.1365-3040.2010.02164.x, http://www.ncbi.nlm.nih.gov/pubmed/20444213, 2010.

Fichot, R., Chamaillard, S., Depardieu, C., Le Thiec, D., Cochard, H., Barigah, T. S., and Brignolas, F.: Hydraulic efficiency and coordination with xylem resistance to cavitation, leaf function, and growth performance among eight unrelated Populus deltoides x Populus nigra hybrids, Journal of Experimental Botany, 62, 2093–106, doi:10.1093/jxb/erq415, http://www.ncbi.nlm.nih.gov/pubmed/21193576, 2011.

Gaspar, M. J. a., Louzada, J. L., Aguiar, A., and Almeida, M. H.: Genetic correlations between wood quality traits of Pinus pinaster Ait, Annals of Forest Science, 65, 703–703, doi:10.1051/forest:2008054, http://link.springer.com/10.1051/forest:2008054, 2008.

Gebauer, T., Horna, V., and Leuschner, C.: Variability in radial sap flux density patterns and sapwood area among seven co-occurring temperate broad-leaved tree species, Tree Physiology, 28, 1821–1830, doi:10.1093/treephys/28.12.1821, http://treephys.oxfordjournals.org/cgi/doi/10.1093/treephys/28.12.1821, 2008.

Gould, P. J. and Harrington, C. A.: Extending sapwood - Leaf area relationships from stems to roots in Coast Douglas-fir, Annals of Forest Science, 65, 802–802, doi:10.1051/forest:2008067, http://link.springer.com/10.1051/forest:2008067, 2008.

Hacke, U. and Sauter, J. J.: Vulnerability of xylem to embolism in relation to leaf water potential and stomatal conductance in Fagus sylvatica f . purpurea and Populus balsamifera, Journal of Experimental Botany, 46, 1177–1183, 1995.

Hickler, T., Prentice, I. C., Smith, B., Sykes, M. T., and Zaehle, S.: Implementing plant hydraulic architecture within the LPJ Dynamic Global Vegetation Model, Global Ecology and Biogeography, 15, 060811081017 001–???, doi:10.1111/j.1466-822X.2006.00254.x, http://onlinelibrary.wiley.com/doi/10.1111/j.1466-8238.2006.00254.x/fullhttp://doi.wiley.com/10.1111/j.1466-822X.2006.00254.x, 2006.

Jenkins, J. C., Chojnacky, D. C., Heath, L. S., and Birdsey, R. A.: National-Scale Biomass Estimators for United States Tree Species, Forest Science, 49, 12–35, 2003.

Knapic, S., Louzada, J. L., Leal, S., and Pereira, H.: Within-tree and between-tree variation of wood density components in cork oak trees in two sites in Portugal, Forestry, 81, 465–473, doi:10.1093/forestry/cpn012, http://forestry.oxfordjournals.org/cgi/doi/10.1093/forestry/cpn012, 2008.

Limousin, J.-M., Rambal, S., Ourcival, J.-M., Rodríguez-Calcerrada, J., Pérez-Ramos, I. M., Rodríguez-Cortina, R., Misson, L., and Joffre, R.: Morphological and phenological shoot plasticity in a Mediterranean evergreen oak facing long-term increased drought, Oecologia, 169, 565–577, doi:10.1007/s00442-011-2221-8, http://www.ncbi.nlm.nih.gov/pubmed/22159896, 2012.

Longuetaud, F., Mothe, F., Leban, J.-M., and Mäkelä, A.: Picea abies sapwood width: Variations within and between trees, Scandinavian Journal of Forest Research, 21, 41–53, doi:10.1080/02827580500518632, http://www.tandfonline.com/doi/abs/10.1080/02827580500518632, 2006.

Magnani, F., Mencuccini, M., and Grace, J.: Age-related decline in stand productivity : the role of structural acclimation under hydraulic constraints, Plant, cell & environment, 23, 251–263, 2000.

Manzoni, S., Vico, G., Katul, G., Palmroth, S., Jackson, R. B., and Porporato, A.: Hydraulic limits on maximum plant transpiration and the emergence of the safety-efficiency trade-off., New Phytologist, 198, 169–78, doi:10.1111/nph.12126, http://www.ncbi.nlm.nih.gov/pubmed/23356378, 2013.

Margolis, H., Oren, R., Whitehead, D., and Kaufmann, M.: Leaf area dynamics of conifer forests, in: Ecophysiology of Coniferous Forests, edited by Smith, W. and Hinckley, T., pp. 181–223, Academic Press, 1995.

Martin, J. G., Kloeppel, B. D., Schaefer, T. L., Kimbler, D. L., and Mcnuity, S. G.: Aboveground biomass and nitrogen allocation of ten deciduous southern Appalachian tree species, Canadian Journal of Forest Research, 28, 1648–1659, 1998.

Martinez-Vilalta, J., Sala, A., and Pinol, J.: The hydraulic architecture of Pinaceae – a review, Plant Ecology, 171, 3–13, 2004.

McDowell, N., Barnard, H., Bond, B., Hinckley, T., Hubbard, R., Ishii, H., Köstner, B., Magnani, F., Marshall, J., Meinzer, F., Phillips, N., Ryan, M., and Whitehead, D.: The relationship between tree height and leaf area:sapwood area ratio, Oecologia, 132, 12–20, doi:10.1007/s00442-002-0904-x, http://link.springer.com/10.1007/s00442-002-0904-x, 2002.

Meadows, J. S. and Hodges, J. D.: Sapwood area as an estimator of leaf area and foliar weight in cherrybark oak and green ash, Forest Science, 48, 69–76, 2002.

Mencuccini, M. and Bonosi, L.: Leaf/sapwood area ratios in Scots pine show acclimation across Europe, Canadian Journal of Forest Research, 31, 442–456, doi:10.1139/cjfr-31-3-442, http://www.nrc.ca/cgi-bin/cisti/journals/rp/rp2_abst_e?cjfr_x00-173_31_ns_nf_cjfr31-01, 2001.

Novick, K., Oren, R., Stoy, P., Juang, J.-Y., Siqueira, M., and Katul, G.: The relationship between reference canopy conductance and simplified hydraulic architecture, Advances in Water Resources, 32, 809–819, doi:10.1016/j.advwatres.2009.02.004, http://linkinghub.elsevier.com/retrieve/pii/S0309170809000232, 2009.

Pinty, B., Lavergne, T., Voß beck, M., Kaminski, T., Aussedat, O., Giering, R., Gobron, N., Taberner, M., Verstraete, M. M., and Widlowski, J.-L.: Retrieving surface parameters for climate models from Moderate Resolution Imaging Spectroradiometer (MODIS)-Multiangle Imaging Spectroradiometer (MISR) albedo products, Journal of Geophysical Research, 112, D10 116, doi:10.1029/2006JD008105, http://doi.wiley.com/10.1029/2006JD008105, 2007.

Pothier, D. and Margolis, H.: Analysis of growth and light interception of balsam fir and white birch saplings following precommercial thinning, Annals of Forest Science, 48, 123–132, 1991.

Pretzsch, H. and Dieler, J.: Evidence of variant intra- and interspecific scaling of tree crown structure and relevance for allometric theory, Oecologia, 169, 637–49, doi:10.1007/s00442-011-2240-5, http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=3375085\&tool=pmcentrez\&rendertype=abstract, 2012.

Quero, J. L., Sterck, F. J., Martínez-Vilalta, J., and Villar, R.: Water-use strategies of six co-existing Mediterranean woody species during a summer drought, Oecologia, 166, 45–57, doi:10.1007/s00442-011-1922-3, http://www.ncbi.nlm.nih.gov/pubmed/21290148, 2011.

Repola, J.: Models for Vertical Wood Density of Scots Pine, Norway Spruce and Birch Stems, and Their Application to Determine Average Wood Density, Silva Fennica, 40, 673–685, 2006.

Ryan, M.: The effects of climate change on plant respiration, Ecological Applications, 1, 157–167, 1991.

Samuelson, L. J., Stokes, T. A., and Coleman, M. D.: Influence of irrigation and fertilization on transpiration and hydraulic properties of Populus deltoides, Tree physiology, 27, 765–774, 2007.

Schäfer, K. V. R., Oren, R., and Tenhunen, J. D.: The effect of tree height on crown level stomatal conductance, Plant, Cell and Environment, 23, 365–375, 2000.

Schulze, E.-D., Cermak, J., Matyssek, R., Penka, M., Zimmerman, R., Vasicek, F., Gries, W., and Kucera, J.: Canopy transpiration and water fluxes in the xylem of the trunk of Larix and Piceu trees - a comparison of xylem flow, porometer and cuvette measurements, Oecologia, 66, 475–483, 1985.

Schulze, E.-D., Schulze, W., Kelliher, F., Vygodskaya, N., Ziegler, W., Kobak, K., Arneth, A., Kusnetsova, W., Sogatchev, A., Issajev, A., Bauer, G., and Hollinger, D.: Abovegound biomass and nitrogen nutrition in a chronosequence of pistine Dahurian Larix stands in eastern Siberia, Canadian Journal of Forest Research, 25, 943–960, 1995.

Sellin, A., Tullus, A., Niglas, A., Õunapuu, E., Karusion, A., and Lõhmus, K.: Humidity-driven changes in growth rate, photosynthetic capacity, hydraulic properties and other functional traits in silver birch (Betula pendula), Ecological Research, 28, 523–535, doi:10.1007/s11284-013-1041-1, http://link.springer.com/10.1007/s11284-013-1041-1, 2013.

Steudle, E.: Water uptake by plant roots: an integration of views, Plant and Soil, 226, 45–56, 2000.

Vincke, C., Granier, A., Bréda, N., and Devillez, F.: Evapotranspiration of a declining Quercus robur (L.) stand from 1999 to 2001. II. Daily actual evapotranspiration and soil water reserve, Annals of Forest Science, 62, 615–623, doi:10.1051/forest:2005060, http://www.edpsciences.org/10.1051/forest:2005060, 2005.

Wullschleger, S. D., Meinzer, F. C., and Vertessy, R. A.: A review of whole-plant water use studies in trees, Tree Physiology, 18, 499–512, 1998.