

Supplementary information for:

Climate and atmospheric deposition effects on forest water-use efficiency and nitrogen availability across Britain

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The PDF file includes:

Tables S1 to S7

Figure S1 to S5

Supplementary text: S1 Output from linear regression analyses to assess relationships between iWUE or $\Delta^{18}\text{O}_w$ vs. change in tree height, Diameter at the breast height and basal area; S2-S3 Output from linear regression analyses to assess relationships between iWUE or $\delta^{15}\text{N}_w$ vs. age and soil types; S4-S6: Output from Linear mixed model analyses for iWUE, $\Delta^{18}\text{O}_w$ and $\delta^{15}\text{N}_w$ including or not Sitka spruce stands (starting from full models with all parameters included and all steps leading to the final models shown in the tables 3 and 4 in the main text).

Table S1. Mean atmospheric deposition at the investigated sites. The mean of total deposition ($\text{NH}_4\text{-N} + \text{NO}_3\text{-N}$) as calculated for the years 1995-2010 at most of the sites, with the exception of Rogate, where we only had one year of monitoring. For Shobdon and Covert Wood, which were not part of the regular ICP forest water chemistry-monitoring network, we considered deposition data as obtained from the UK 5x5 km grid N_{dep} and S_{dep} dataset from RoTAP, (2012) (see methods for details).

Site	Species	Year monitoring	Mean Total deposition ($\text{kg ha}^{-1} \text{yr}^{-1}$)	
			N_{dep}	S_{dep}
Alice Holt	<i>Fagus sylvatica</i>	1995-2010	9.8	9.6
	<i>Quercus robur</i>			
Covert Wood	<i>Fagus sylvatica</i>	N_{dep} map	6.7	3.7
Goyt	<i>Picea sitchensis</i>	1995-2010	15.2	16.5
LadyBower	<i>Pinus sylvestris</i>			
Rannoch	<i>Pinus sylvestris</i>	1995-2010	4.8	5.1
Rogate	<i>Pinus sylvestris</i>	2010	10.7	4.1
Savernake	<i>Quercus robur</i>	1995-2010	12.7	10.9
Shobdon	<i>Fagus sylvatica</i>	N_{dep} map	14.8	6.6
Thetford	<i>Fagus sylvatica</i>	1995-2010	19.7	9.5
	<i>Pinus sylvestris</i>	1995-2010	13.6	7.5
Tummel	<i>Picea sitchensis</i>	1995-2010	4.8	6.4

Table S2. Temporal changes in tree iWUE across the investigated sites. Relative changes in iWUE (i.e., value at 2010 minus value at 1980 divided by value at 1980, iWUE (%)) and slope ($\mu\text{mol mol}^{-1} \text{ year}^{-1}$) $\pm$ standard error (SE) from linear regression analyses exploring i) trends in iWUE over the investigated years and ii) relationship between iWUE and $\Delta^{18}\text{O}_w$ for the four species at the twelve forest stands included in the study. Slopes significantly different from zero were indicated by stars, according to the *p*- values: *, ¥ , $p \leq 0.10$, $p \leq 0.05$; **, $p \leq 0.01$; ***, $p \leq 0.001$

Species	Site	iWUE (%)	iWUE vs. year	iWUE vs. $\Delta^{18}\text{O}_w$
			Slope $\pm$ SE	Slope $\pm$ SE
Beech	Shobdon	5.1	0.02 ± 0.18	$4.85 \pm 2.63 \text{¥}$
	Alice Holt	16.6	$0.43 \pm 0.14^{**}$	1.25 ± 3.63
	Thetford	19.9	0.03 ± 0.18	3.57 ± 2.97
	Covert Wood	19.6	0.14 ± 0.15	$3.30 \pm 1.94 \text{¥}$
Scots pine	Rannoch	25.8	$0.54 \pm 0.09^{***}$	-4.10 ± 3.14
	Ladybower	17.5	$0.36 \pm 0.08^{***}$	$6.03 \pm 2.30^*$
	Thetford	13.6	$0.44 \pm 0.11^{***}$	$5.21 \pm 1.45^{**}$
	Rogate	14.4	$0.36 \pm 0.11^{**}$	1.17 ± 2.59
Oak	Alice Holt	30.5	$0.73 \pm 0.09^{***}$	1.50 ± 3.47
	Savernake	14.5	$0.21 \pm 0.08^*$	1.29 ± 1.77
Sitka spruce	Tummel	-15.5	$-0.24 \pm 0.12 \text{¥}$	$7.50 \pm 2.58^{**}$
	Goyt	-29.6	$-1.36 \pm 0.12^{***}$	-7.55 ± 6.58

Table S3. Differences between tree species at high vs. low N_{dep} sites for tree ring $\delta^{15}N_w$ values. The average of the year-by-year differences and the relative confidence interval are reported.

Species	Site	Diff $\delta^{15}N_w$ (‰)	CI
Beech	Thetford vs. Alice Holt	1.57	0.48
Scots pine	Ladybower vs. Rannoch	-1.32	0.41
	Thetford vs. Rogate	-0.79	0.60
Oak	Savernake vs. Alice Holt	-1.00	0.33
Sitka spruce	Goyt vs. Tummel	-1.84	0.70

Table S4. Relationship between iWUE vs. climate factors and atmospheric CO₂ per level of N_{dep}. Statistics of the linear mixed model analyses for the regression of iWUE as a function of the site (PC_s) and time (PC_a) climate variables from PCA analysis, and changes in atmospheric CO₂ (c_a). Output is given separately for the forest stands at high and low Ndep and with or without the Sitka spruce stands. Estimate of slope and intercept and standard error (SE) values are provided for each of the fixed factor. Marginal (only fixed factors) and conditional (fixed + random factors) proportions of the explained variance are indicated as R²_m and R²_c, respectively.

Fixed effects	Estimate $\pm$ SE		Auto-correlation structure	Random effects standard deviation	Residual variance	R^2_m	R^2_c
i) High N_{dep} sites - All sites			0.56	6.20	5.18	0.15	0.44
Intercept	83.79 $\pm$ 4.10	***					
c_a	0.02 $\pm$ 0.09	n.s.					
PCA_s1	-3.36 $\pm$ 2.61	n.s.					
PCA_a1	-0.46 $\pm$ 0.17	**					
PCA_a3	-0.35 $\pm$ 0.28	n.s.					
ii) High N_{dep} sites - without Sitka spruce			0.49	6.63	5.09	0.26	0.72
Intercept	81.82 $\pm$ 4.14	***					
c_a	0.13 $\pm$ 0.06	*					
PCA_s1	-3.39 $\pm$ 2.45	n.s.					
PCA_a1	-0.48 $\pm$ 0.20	*					
PCA_a3	-0.25 $\pm$ 0.31	n.s.					
iii) Low N_{dep} - All sites			0.59	4.96	5.29	0.40	0.68
Intercept	83.48 $\pm$ 2.38	***					
c_a	0.16 $\pm$ 0.06	**					
PCA_s1	-1.67 $\pm$ 0.74	**					
PCA_a1	-0.84 $\pm$ 0.19	0.08					
PCA_a3	-0.30 $\pm$ 0.29	n.s.					
iv) Low N_{dep} sites - without Sitka spruce			0.51	5.32	4.69	0.38	0.73
Intercept	84.14 $\pm$ 2.58	***					
c_a	0.23 $\pm$ 0.05	***					
PCA_s1	-1.31 $\pm$ 0.87	n.s.					
PCA_a1	-0.81 $\pm$ 0.19	**					
PCA_a3	-0.32 $\pm$ 0.30	n.s.					

Table S5. Mean $\pm$ standard error (SE) calculated over n=10 trees for the year 2007 for each species at eight of the twelve forest stands for $\delta^{13}\text{C}_w$ and $\delta^{18}\text{O}_w$.

Site	Species	$\delta^{13}\text{C}_w$	SE	$\delta^{18}\text{O}_w$	SE
Alice Holt	Beech	-28.18	0.66	25.44	0.24
	Oak	-27.11	0.27	24.67	0.17
Goyt	Sitka spruce	-27.73	0.31	22.69	0.14
Ladybower	Scots pine	-26.66	0.28	23.34	0.30
Rogate	Scots pine	-25.98	0.31	24.76	0.16
Savernake	Oak	-27.53	0.23	24.32	0.18
Thetford	Beech	-28.01	0.80	25.83	0.18
Tummel	Sitka spruce	-28.00	0.16	22.19	0.14

Table S6. Comparing estimates of $\delta^{18}\text{O}$ in precipitation ($\delta^{18}\text{O}_p$) as obtained from eq. 5 (ref. Methods) with those obtained from the Online Isotopes in Precipitation Calculator, http://wateriso.utah.edu/waterisotopes/pages/data_access/oipc.html) and measured values at Keyworth in England. We report i) the mean of estimated $\delta^{18}\text{O}_p$ values over the years considered in this study (1980-2010), ii) single value as obtained from the online calculator, by including coordinates and elevation ^[*]; iii) mean of measured $\delta^{18}\text{O}_p$ values from 1985 to 1996 ^[#]. Mean $\pm$ standard deviation values across all sites are -8.2 ± 0.5 and -7.5 ± 0.6 for estimates obtained in this study and those from Bowen et al. 2020, respectively.

Species	Site	Estimated $\delta^{18}\text{O}_p$		Measured $\delta^{18}\text{O}_p$
		This study	Bowen (2020)	IAEA
Beech	Shobdon	-8.1	-7.8	-7.7 ± 0.7
	Alice Holt	-7.9	-7.1	-7.7 ± 0.7
	Thetford	-7.8	-7.5	-7.7 ± 0.7
	Covert Wood	-7.5	-6.9	-7.7 ± 0.7
Scots pine	Rannoch	-9.1	-8.1	-7.7 ± 0.7
	Ladybower	-8.6	-8.4	-7.7 ± 0.7
	Thetford	-7.8	-7.5	-7.7 ± 0.7
	Rogate	-7.9	-7	-7.7 ± 0.7
Oak	Alice Holt	-7.9	-7.1	-7.7 ± 0.7
	Savernake	-7.9	-7.3	-7.7 ± 0.7
Sitka spruce	Tummel	-9.0	-7.0	-7.7 ± 0.7
	Goyt	-8.6	-8.6	-7.7 ± 0.7

[*] Bowen, G. J. (2020) The Online Isotopes in Precipitation Calculator, version OIPC3.1 (4/2017). <http://www.waterisotopes.org>. Bowen G. J. and Revenaugh J. (2003). Interpolating the isotopic composition of modern meteoric precipitation. *Water Resources Research* **39** (10), 1299.

[#] IAEA/WMO (2015). Global Network of Isotopes in Precipitation. The GNIP Database. Accessible at: <https://nucleus.iaea.org/wiser>.

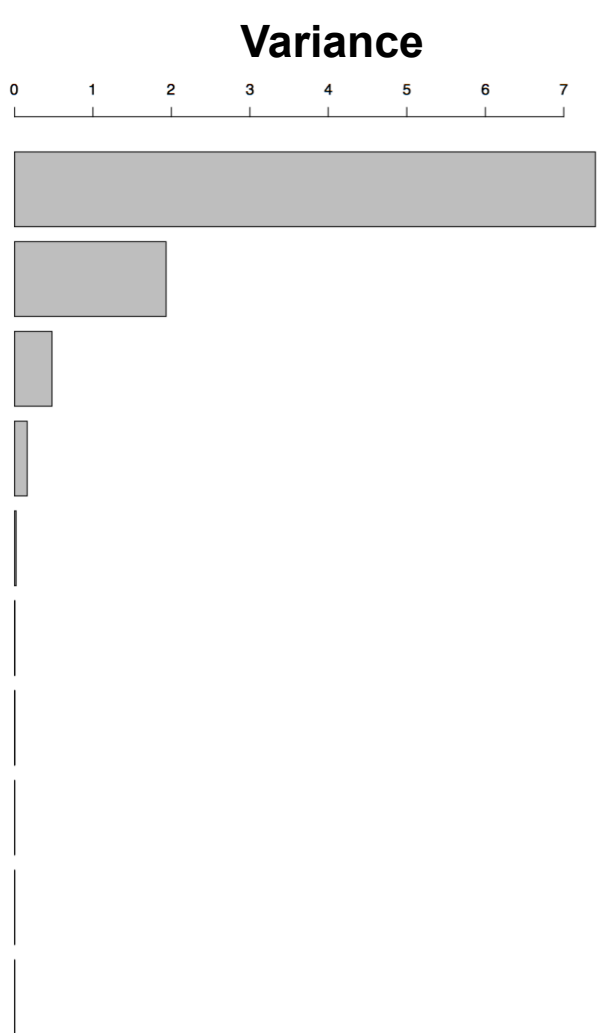
Table S7. Summary of all statistical models tested in this study and reference (Ref.) to the figure/table or supplementary text where results are reported. LM, LME and SEM indicate linear, linear mixed-effect and structural equation models.

N of sites	Analysis - Equations	Ref.
Linear regression		
All	iWUE~Year	Fig. 2, Table S2
	c _i /c _a ~Year	Fig. 2
	Δ ¹⁸ O _w ~Year	Fig. 2
	δ ¹⁵ N _w ~Year	Fig. 2
	iWUE ~ tree height; diameter at the breast height; basal area Δ ¹⁸ O _w ~ tree height; diameter at the breast height; basal area	Text S1
Linear mixed models (LME) – iWUE all sites		
12	iWUE ~ Age + Soil type	Text S2
10	iWUE ~ PFT + pca_s1 + pca_a1 + pca_a3 + sNdep + sSdep + c _a + aSdep + aNdep	Table 3
12	iWUE~ PFT + pca_s1 + pca_a1 + pca_a3 + sSdep +sNdep+ c _a	Text S4
	iWUE ~ PFT + pca_s1 + pca_a1 + pca_a3+ c _a	Text S4
	iWUE ~ PFT + pca_s1 + pca_a1 + pca_a3	Table 3
	iWUE ~ PFT + Age + Soil type + pca_s1 + pca_a1 + pca_a3	Text S2
Linear mixed models (LME) – iWUE without Sitka spruce stands		
8	iWUE ~ PFT + pca_s1 + pca_a1 + pca_a3 + sNdep + sSdep + c _a + aSdep + aNdep	Text S4
	iWUE ~ PFT + pca_s1 + pca_a1 + pca_a3 + sSdep + aSdep	Table 3
10	WUE~ PFT + pca_s1 + pca_a1 + pca_a3 + sSdep +sNdep+ c _a	Text S4
	WUE~ PFT + pca_s1 + pca_a1 + pca_a3 + sSdep + c _a	Table S4
	WUE~ PFT + pca_s1 + pca_a1 + c _a	Table 3
Linear mixed models (LME) – iWUE per level of Ndep, with or without Sitka spruce stands		
6 low	iWUE ~ PFT + pca_s1 + pca_a1 + pca_a3 + c _a	Table S4
6 high		
Linear mixed models (LME) – Δ ¹⁸ O _w all sites and all parameters		
10	Δ ¹⁸ O _w ~ pca_s1 + pca_a1 + pca_a2 + pca_a3 + c _a + PFT + sNdep + sSdep + aNdep+aSdep (all parameters)	Text S5
	Δ ¹⁸ O _w ~ pca_s1 + pca_a1 + pca_a2 + pca_a3 +PFT + aSedep+ sSdep (final model for all sites model)	Table 4
12	Δ ¹⁸ O _w ~ pca_s1 + pca_a1 + pca_a2 + pca_a3 +PFT + sSdep+sNdep+c _a (all parameters)	Text S5
	Δ ¹⁸ O _w ~ pca_s1 + pca_a1 + pca_a2 + pca_a3 +PFT+ sSdep (final model for all parameters model)	Table 4
Linear mixed models (LME) – Δ ¹⁸ O _w without Sitka spruce stands – all parameters and all sites		
8	Δ ¹⁸ O _w ~ pca_s1 + pca_a1 + pca_a2+ pca_a3 + c _a + PFT + sNdep + sSdep + aNdep+aSdep (all parameters)	Text S5
10	Δ ¹⁸ O _w ~ pca_s1 + pca_a1 + pca_a3 + PFT + cNdep + cSdep+ c _a (best model for all parameters = model all sites)	Text S5
	Δ ¹⁸ O _w ~ pca_s1 + pca_a1 + pca_a2 + PFT (final model for all parameters and all sites)	Table 4
Linear mixed models (LME) – δ ¹⁵ N _w all sites		
10	δ ¹⁵ N _w ~ PFT + pca_s1 + pca_a1 + pca_a3 + c _a + sNdep + aNdep	Text S6

	$\delta^{15}\text{N}_w \sim \text{PFT} + \text{pca_s1} + \text{pca_a1} + \text{pca_a3} + \text{sNdep} + \text{aNdep}$	Text S6
	$\delta^{15}\text{N}_w \sim \text{PFT} + \text{pca_s1} + \text{Ndep_lev}$	Text S6
	$\delta^{15}\text{N}_w \sim \text{Years} * \text{Ndep_lev}$	Text S6
	$\delta^{15}\text{N}_w \sim \text{PFT} + \text{pca_s1} + \text{sNdep}$	Table 4
	$\delta^{15}\text{N}_w \sim \text{pca_s1} + \text{sNdep} + \text{Age} + \text{Soil type}$	Text S3
Linear mixed models (LME) – $\delta^{15}\text{N}_w$ without Sitka spruce stands		
8	$\delta^{15}\text{N}_w \sim \text{PFT} + \text{pca_s1} + \text{pca_a1} + \text{pca_a3} + \text{c}_a + \text{sNdep} + \text{aNdep}$	Text S6
	$\delta^{15}\text{N}_w \sim \text{PFT} + \text{pca_s1} + \text{Ndep_lev}$	Text S6
	$\delta^{15}\text{N}_w \sim \text{Years} * \text{Ndep_lev}$	Text S6
	$\delta^{15}\text{N}_w \sim \text{PFT} + \text{pca_s1} + \text{sNdep}$	Text S6
SEM – all sites (We considered final equations from LME models, but PFT was excluded and $\Delta^{18}\text{O}_w$ was included in the iWUE model)		
12	$\text{lme}(\text{iWUE} \sim \text{pca_a1} + \text{pca_s1} + \text{pca_a3} + \Delta^{18}\text{O}_w, \text{correlation}=\text{corAR1}(0, \text{form}=\sim 1 \text{Site_Sp}), \text{random}=\sim 1 \text{Site_Sp})$ $\text{lme}(\Delta^{18}\text{O}_w \sim \text{pca_s1} + \text{pca_a1} + \text{pca_a2} + \text{pca_a3} + \text{sSdep}, \text{correlation}=\text{corAR1}(0, \text{form}=\sim 1 \text{Site_Sp}), \text{random}=\sim 1 \text{Site_Sp})$ $\text{lme}(\delta^{15}\text{N}_w \sim \text{pca_s1} + \text{sNdep}, \text{correlation}=\text{corAR1}(0, \text{form}=\sim 1 \text{Site_Sp}), \text{random}=\sim 1 \text{Site_Sp})$ $\text{pca_s1} \% \sim \% \text{sNdep}$ (to account for covariance between pca_s1 and sNdep)	Fig.4A
SEM – all sites without Sitka spruce (We considered final equations from LME models, but PFT was excluded and $\Delta^{18}\text{O}_w$ was included in the iWUE model)		
10	$\text{lme}(\text{iWUE} \sim \text{pca_a1} + \text{pca_s1} + \Delta^{18}\text{O}_w + \text{c}_a, \text{correlation}=\text{corAR1}(0, \text{form}=\sim 1 \text{Site_Sp}), \text{random}=\sim 1 \text{Site_Sp})$ $\text{lme}(\Delta^{18}\text{O}_w \sim \text{pca_a1} + \text{pca_a2}, \text{correlation}=\text{corAR1}(0, \text{form}=\sim 1 \text{Site_Sp}), \text{random}=\sim 1 \text{Site_Sp})$ $\text{lme}(\delta^{15}\text{N}_w \sim \text{pca_s1} + \text{sNdep}, \text{correlation}=\text{corAR1}(0, \text{form}=\sim 1 \text{Site_Sp}), \text{random}=\sim 1 \text{Site_Sp})$ $\text{pca_s1} \% \sim \% \text{sNdep}$	Fig. 4B
SEM – all parameters without Sitka spruce (We considered final equations from LME models, but PFT was excluded and $\Delta^{18}\text{O}_w$ was included in the iWUE model)		
8	$\text{lme}(\text{iWUE} \sim \text{pca_a1} + \text{pca_s1} + \text{pca_a3} + \Delta^{18}\text{O}_w + \text{sSdep} + \text{aSdep}, \text{correlation}=\text{corAR1}(0, \text{form}=\sim 1 \text{Site_Sp}), \text{random}=\sim 1 \text{Site_Sp})$ $\text{lme}(\Delta^{18}\text{O}_w \sim \text{pca_s1} + \text{pca_a2}, \text{correlation}=\text{corAR1}(0, \text{form}=\sim 1 \text{Site_Sp}), \text{random}=\sim 1 \text{Site_Sp})$ $\text{lme}(\delta^{15}\text{N}_w \sim \text{pca_s1} + \text{sNdep}, \text{correlation}=\text{corAR1}(0, \text{form}=\sim 1 \text{Site_Sp}), \text{random}=\sim 1 \text{Site_Sp})$ $\text{pca_s1} \% \sim \% \text{sNdep}$	Fig. S4

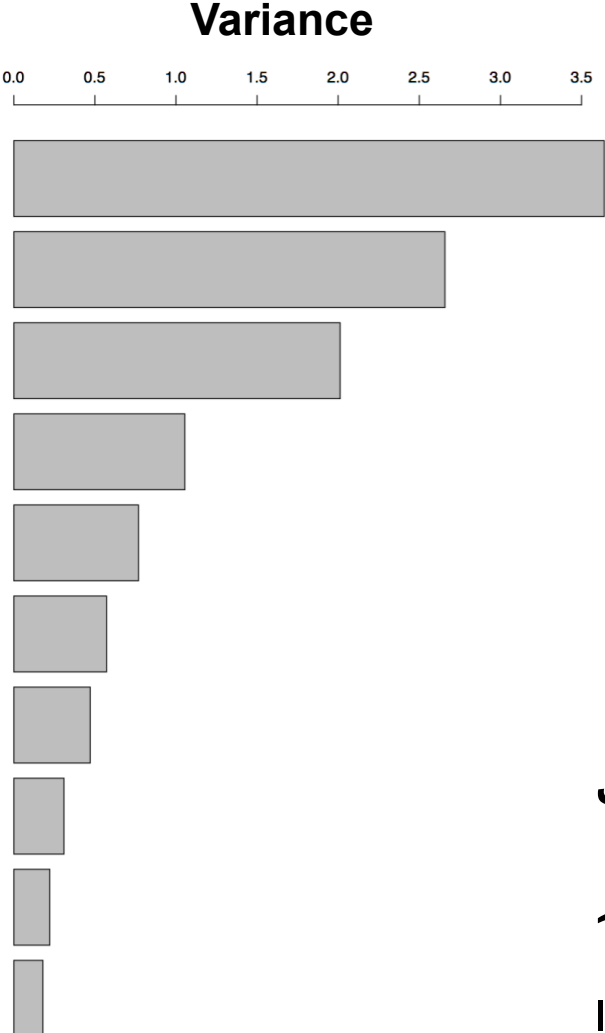
Figure S1. Results from the PCA analyses. Scree plots of the PCA analyses including across sites long-term averages of environmental variables (PCA_s, panel A) and within sites annual time series (PCA_a, panel 2). Next to each plot we also report the tables of percentage of variance explained by the retained PC axis and considered in the statistical analyses reported in the main text.

A) **Site PCA analysis (PCA_s)**



	PC1	PC2
Prec_grs	0.3429950	-0.169030097
Prec_annual	0.3595289	0.006232595
VPD_grs	-0.3298303	-0.550739278
VPD_annual	-0.3007576	-0.665895925
T_grs	-0.3729435	0.275024023
T_annual	-0.3586107	0.327860946
Tmax_grs	-0.3768732	0.106149050
Tmax_annual	-0.3796423	0.173954628

B) **Annual PCA analysis (PC_a)**



	PC1	PC2	PC3
SPEI8_1	0.19236594	0.06015290	-0.53304052
SPEI8_2	0.28107766	0.04652127	-0.49601301
SPEI12_1	-0.01250284	-0.39401102	0.26130785
SPEI12_12	0.35555742	-0.29464376	-0.09286985
Tmax_grs	-0.34421189	-0.20628203	-0.23548662
T_grs	-0.27939844	-0.32416604	-0.25092423
Tmax_annual	-0.26450909	-0.40729600	-0.02815323
T_annual	-0.16441678	-0.49641964	0.01189985
P_grs	0.32276232	-0.21031195	-0.20731192
P_annual	0.31097367	-0.32217869	-0.14714354
VPD_grs	-0.37039635	0.15812636	-0.31827907
VPD_annual	-0.35467795	0.13843849	-0.32810082

Figure S2. Tree-ring $\delta^{15}\text{N}$ vs. %N. Linear regression analyses to assess relationships between $\delta^{15}\text{N}$ and %N values measured in tree rings. Only sites where relationships were significant are reported (i.e., AH=Alice Holt; TH=Thetford; RO=Rogate;

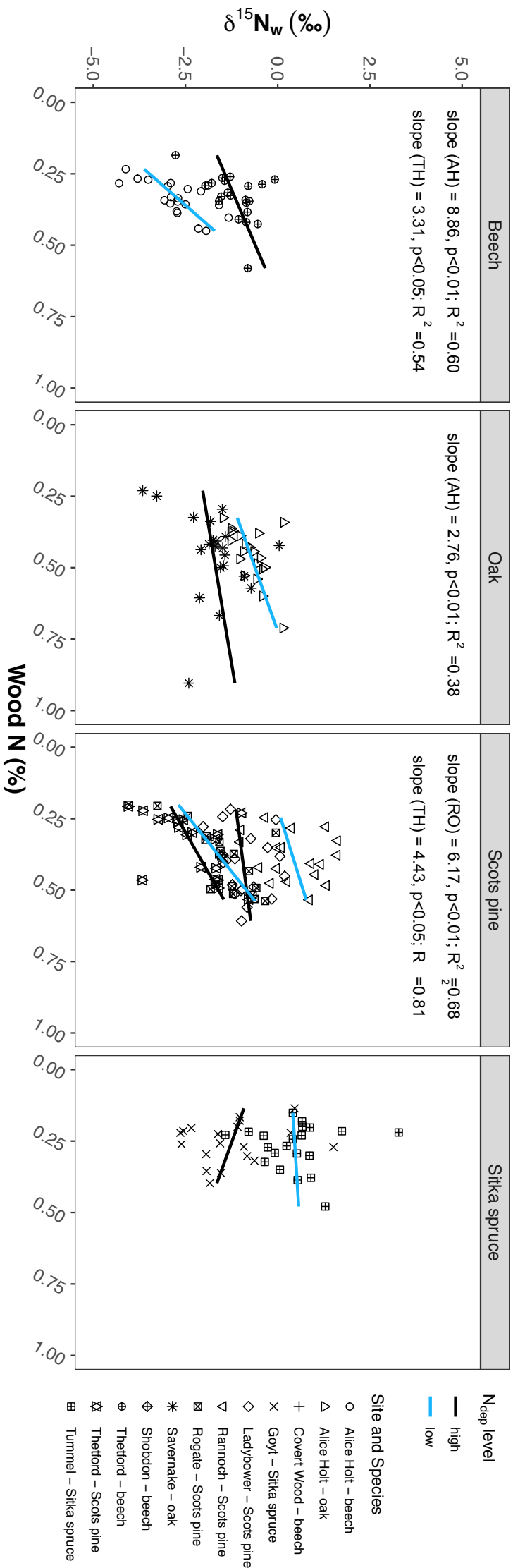


Figure S3. Comparison of iWUE and $\Delta^{18}\text{O}_w$ for two species at the same site.
Boxplot showing iWUE and $\Delta^{18}\text{O}_w$ values measured for oak and beech trees at Alice Holt.

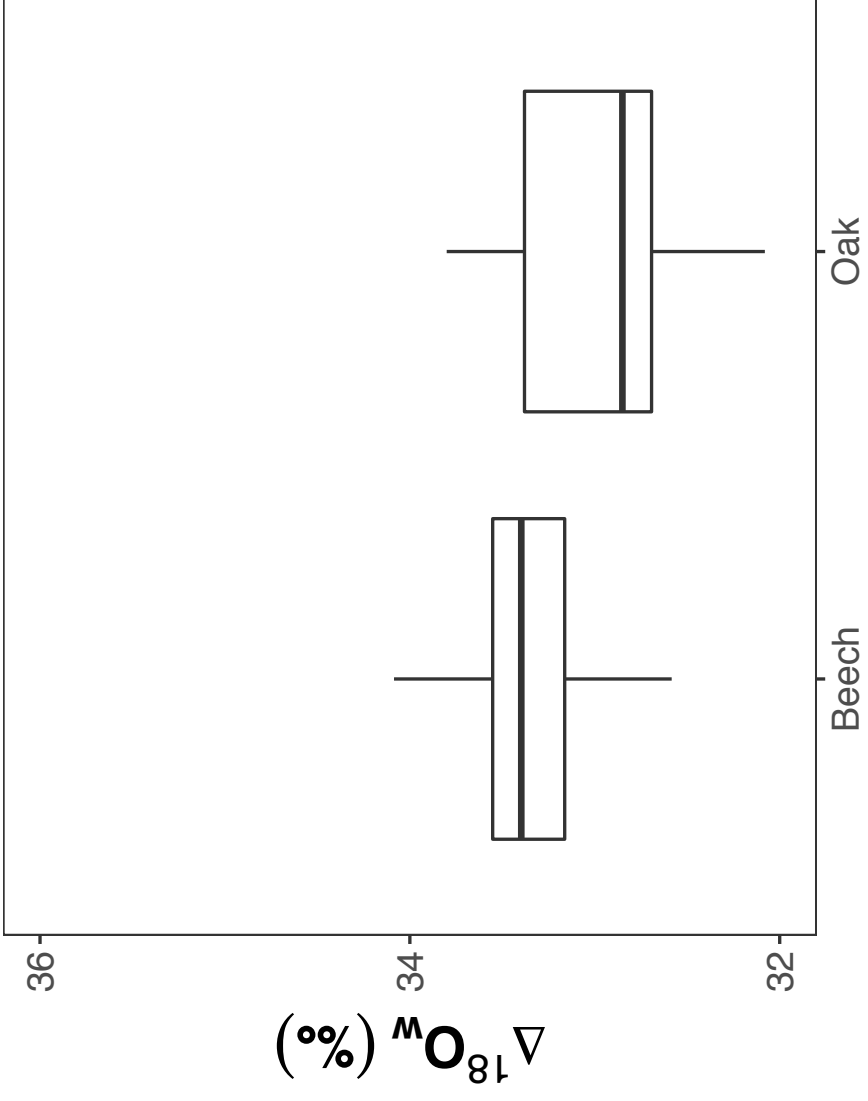
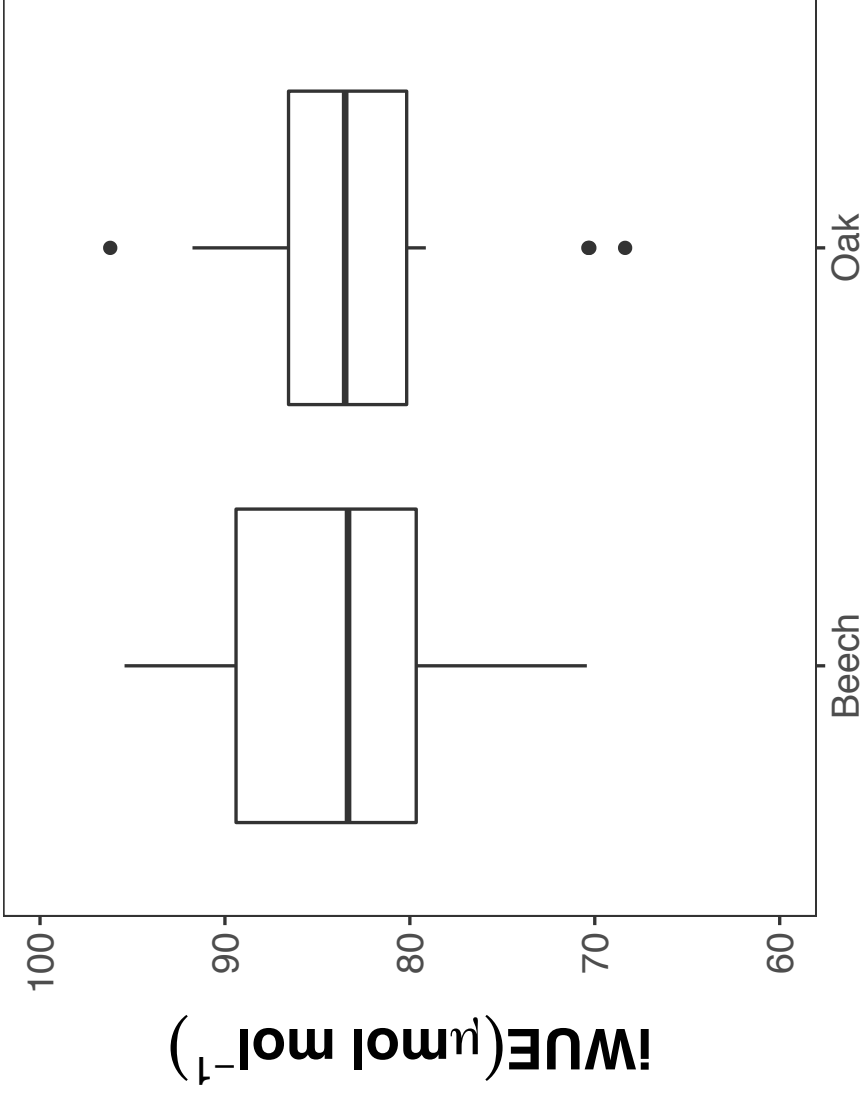


Figure S4. Stand-related parameters at seven of the twelve investigated sites. Boxplots showing variations in mean tree height (m), diameter and breast height (DBH, cm) and basal area (m^2/ha). Full names of sites and species: AHOA= Alice Holt, oak (5); SAOA= Savernake, oak (4); COBE= Covert Wood, beech (3); THSP= Thetford, Scots pine (4); LBSP = Ladybower, Scots pine (5); RASP= Rannoch, Scots pine (4); TUSS= Tummel, Sitka spruce (5). In brackets are indicated the number of years data were available for. Note that Cover Wood was removed from the analyses shown in the Supplementary text S1, as for some parameters there were data only for 2 years.

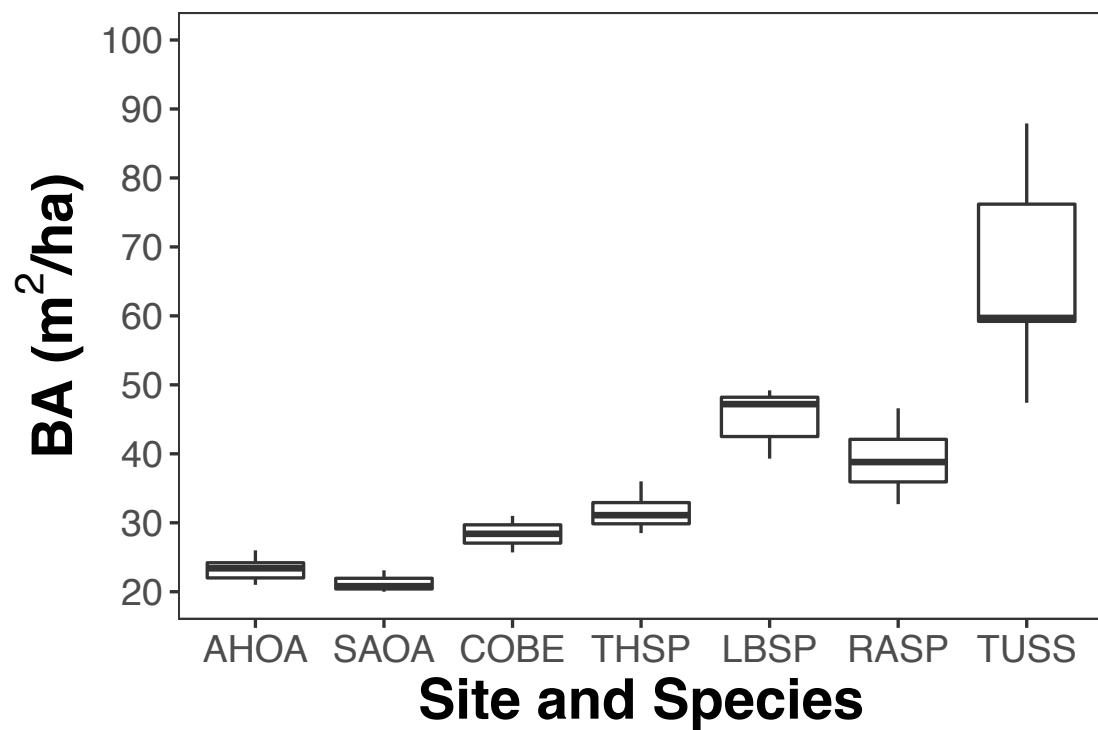
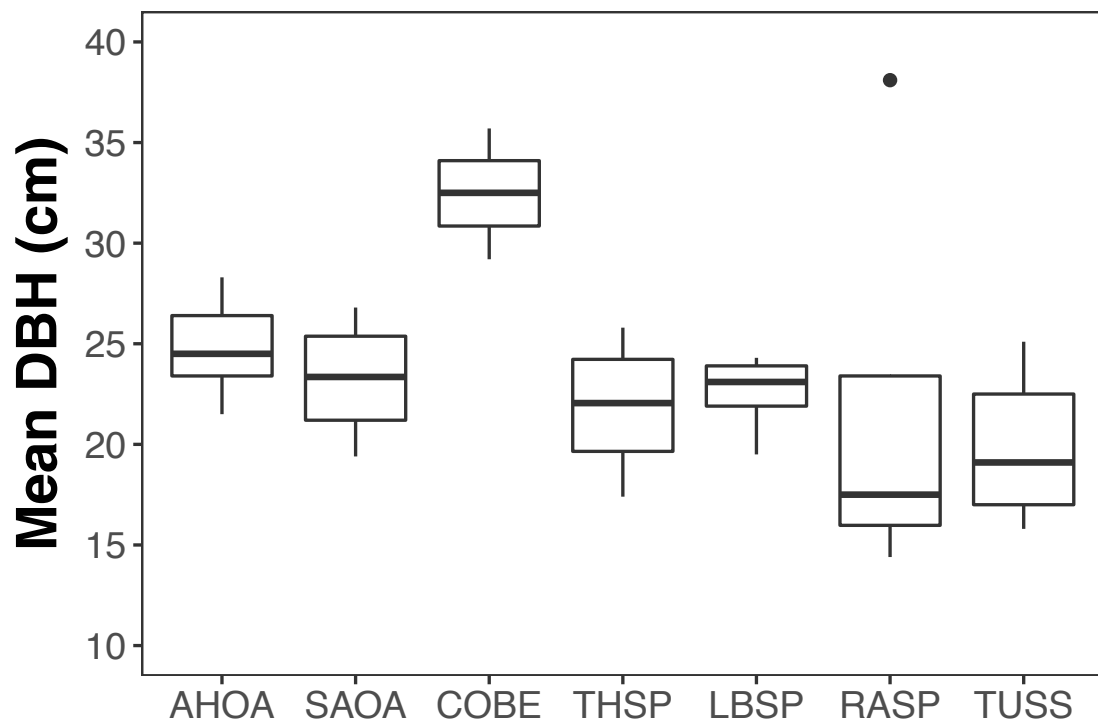
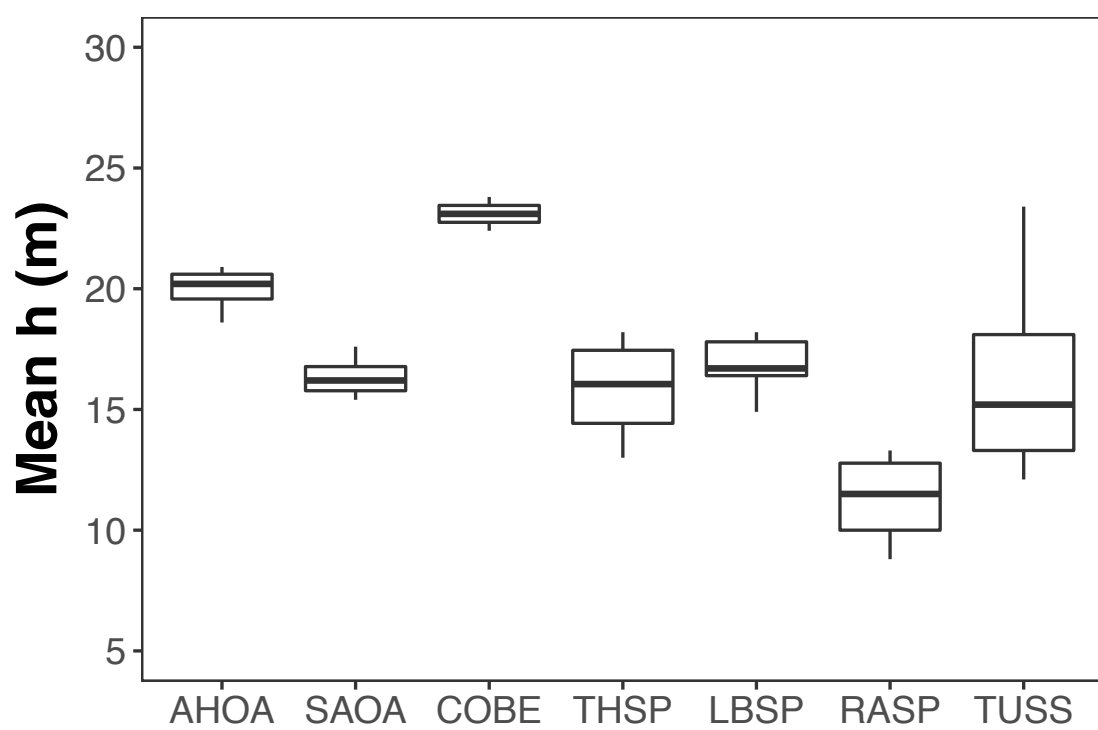
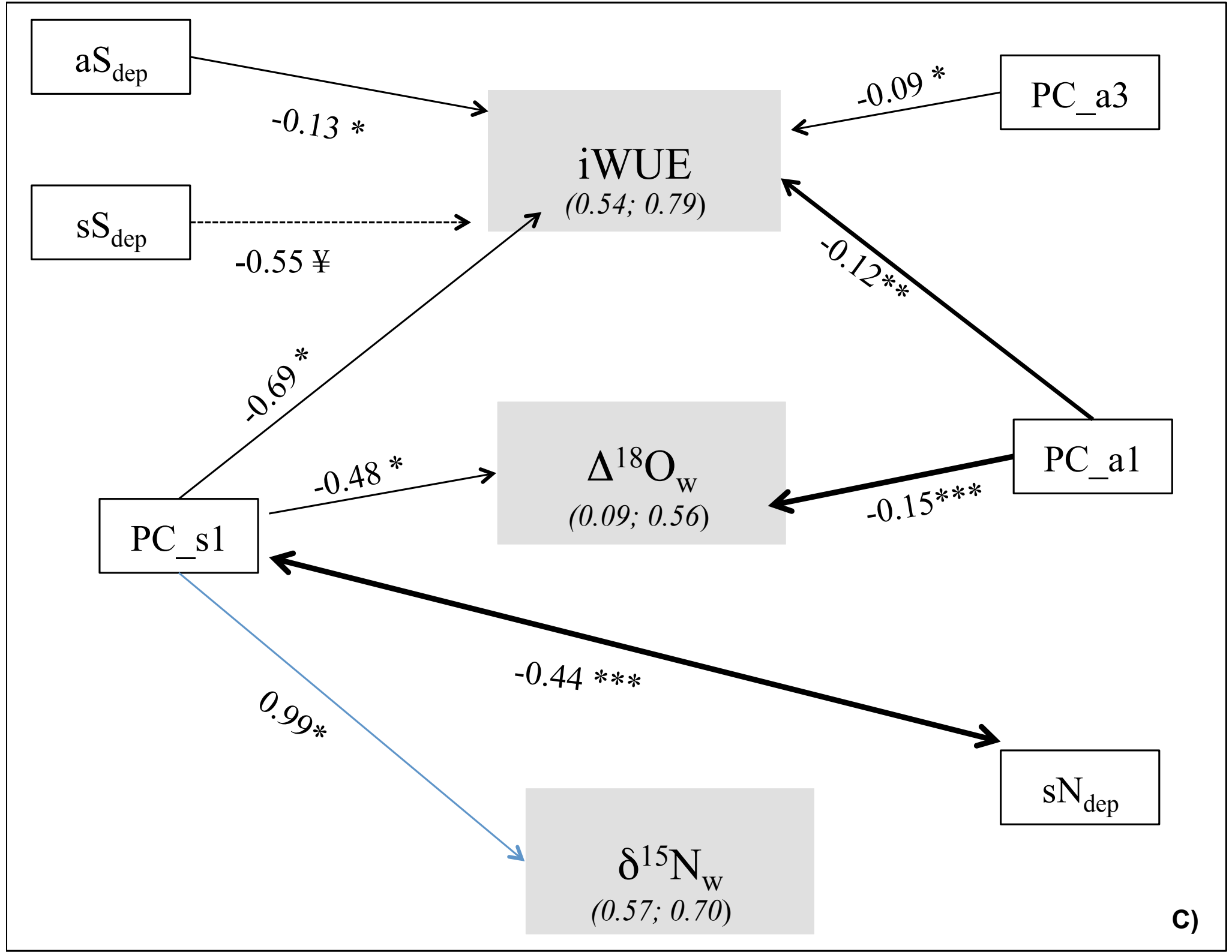


Figure S5. Direct and indirect effects on tree-ring stable isotopes and derived physiological parameters. Result from the structural equation modelling analysis, which included all parameters and all sites but the two Sitka spruce stands. Continuous arrows indicate relationships significant at the $p \leq 0.05$ or greater (depending on number of stars, i.e., *, $p \leq 0.05$; **, $p \leq 0.01$; ***, $p \leq 0.001$). Dashed arrows (and the ‘¥’ symbol) indicate relationship significant at $p \leq 0.10$. Thickness of lines reflects level of significance. Black and blue arrows indicate negative and positive relationships, respectively. Double-headed arrow indicates correlated errors between variables. PC_s1 indicates the first component from the PCA_s (using long-term average climate variables across sites) and PC_a1 and PC_a3 the first two principal components from the PCA_a (using annual climatic anomalies). Numbers next to the paths indicate standardized path coefficients. Numbers below each isotope-related parameters indicate marginal and conditional R^2 , respectively as obtained from LME models described in the Table S7. Notice that they are not the same as reported in Tables 3 and 4 (i.e., PFT was not included as fixed factor in any model, while $\Delta^{18}\text{O}_w$ was included as fixed factor in the model for iWUE).



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#####
#####Supplementary text S1#####
#####
Output from linear regression between iWUE or Oxygen isotope discrimination (D18Ow) and
stand parameters measured 4-5 years within the 1995-2010 time-window.
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For full name of sites and Species refer to Caption to Figure S4.

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#####
SiteSP= Site and Species
#####
```

###Relationship between iWUE and mean diameter at the breast height (Mean DBH) for each forest stand###

	SiteSP (Intercept)	Mean DBH
1	AHOA 69.24055	0.6939927
2	LBSP 41.24976	1.7220454
3	RASP 82.98656	-0.2853592
4	SAOA 75.94862	0.3908009
5	THSP 82.00124	1.0572559
6	TUSS 75.43735	-0.1640974

Call:
lm(formula = iWUE ~ Mean DBH, data = data)

Residuals:

1	2	3	4	5
3.3673	-0.5380	-4.9604	-0.7428	2.8740

Coefficients:

	Estimate	Std. Error	t value	Pr(> t)
(Intercept)	69.2406	18.3400	3.775	0.0325 *
Mean DBH	0.6940	0.7356	0.943	0.4151

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 3.875 on 3 degrees of freedom
Multiple R-squared: 0.2288, Adjusted R-squared: -0.02827
F-statistic: 0.89 on 1 and 3 DF, p-value: 0.4151

Call:
lm(formula = iWUE ~ Mean DBH, data = data)

Residuals:

1	2	3	4	5
1.702	-3.805	1.234	-1.294	2.164

Coefficients:

	Estimate	Std. Error	t value	Pr(> t)
(Intercept)	41.2498	16.9833	2.429	0.0934 .
Mean DBH	1.7220	0.7513	2.292	0.1057

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 2.901 on 3 degrees of freedom
Multiple R-squared: 0.6365, Adjusted R-squared: 0.5154
F-statistic: 5.254 on 1 and 3 DF, p-value: 0.1057

Call:
lm(formula = iWUE ~ Mean DBH, data = data)

Residuals:

1	2	3	4
-0.3853	-1.3454	-1.0179	2.7486

Coefficients:

	Estimate	Std. Error	t value	Pr(> t)
(Intercept)	82.9866	2.8882	28.733	0.00121 **

```

Mean DBH      -0.2854      0.1211  -2.355  0.14265
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 2.297 on 2 degrees of freedom
Multiple R-squared:  0.735,    Adjusted R-squared:  0.6026
F-statistic: 5.548 on 1 and 2 DF,  p-value: 0.1427

```

```

Call:
lm(formula = iWUE ~ Mean DBH, data = data)

```

```

Residuals:
      1      2      3      4
-0.1776  1.7669 -3.9579  2.3686

```

```

Coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept)  75.9486    14.4000   5.274  0.0341 *
Mean DBH      0.3908     0.6154   0.635  0.5904
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

```

```

Residual standard error: 3.495 on 2 degrees of freedom
Multiple R-squared:  0.1678,    Adjusted R-squared:  -0.2483
F-statistic: 0.4032 on 1 and 2 DF,  p-value: 0.5904

```

```

Call:
lm(formula = iWUE ~ Mean DBH, data = data)

```

```

Residuals:
      1      2      3      4
 4.1562 -6.1203 -0.8866  2.8508

```

```

Coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept)  82.0012    19.4504   4.216  0.0519 .
Mean DBH      1.0573     0.8818   1.199  0.3533
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

```

```

Residual standard error: 5.641 on 2 degrees of freedom
Multiple R-squared:  0.4182,    Adjusted R-squared:  0.1273
F-statistic: 1.438 on 1 and 2 DF,  p-value: 0.3533

```

```

Call:
lm(formula = iWUE ~ Mean DBH, data = data)

```

```

Residuals:
      1      2      3      4      5
 5.5780 -3.6947 -3.8208  0.3754  1.5620

```

```

Coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept)  75.4374    11.8821   6.349  0.00791 **
Mean DBH     -0.1641     0.5883  -0.279  0.79842
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

```

```

Residual standard error: 4.544 on 3 degrees of freedom
Multiple R-squared:  0.02528,    Adjusted R-squared:  -0.2996
F-statistic: 0.07781 on 1 and 3 DF,  p-value: 0.7984

```

###Relationship between iWUE and mean height (MeanH) for each forest stand###

	SiteSP (Intercept)	MeanH
1	AHOA 63.14791	1.23219888
2	LBSP 38.24942	2.48900210
3	RASP 59.12230	1.56292873

```

4    SAOA    53.07875  1.95389708
5    THSP    79.17519  1.63669254
6    TUSS    73.70414 -0.09332065

```

```

Call:
lm(formula = iWUE ~ MeanH, data = data)

```

```

Residuals:
    1      2      4      5
1.462 -2.727 -1.589  2.854

```

```

Coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept)   63.148     36.555   1.727   0.226
MeanH          1.232      1.828   0.674   0.570

```

```

Residual standard error: 3.181 on 2 degrees of freedom
(1 observation deleted due to missingness)
Multiple R-squared:  0.1851,    Adjusted R-squared:  -0.2224
F-statistic: 0.4542 on 1 and 2 DF,  p-value: 0.5698

```

```

Call:
lm(formula = iWUE ~ MeanH, data = data)

```

```

Residuals:
    1      2      3      4      5
1.196 -3.911  2.447 -1.441  1.710

```

```

Coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept)   38.249     19.716   1.940   0.148
MeanH          2.489      1.171   2.126   0.123

```

```

Residual standard error: 3.039 on 3 degrees of freedom
Multiple R-squared:  0.6011,    Adjusted R-squared:  0.4681
F-statistic: 4.52 on 1 and 3 DF,  p-value: 0.1235

```

```

Call:
lm(formula = iWUE ~ MeanH, data = data)

```

```

Residuals:
    1      2      3      4
-1.1470  2.1552 -1.5549  0.5468

```

```

Coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept)   59.1223     6.6597   8.878  0.0125 *
MeanH          1.5629      0.5834   2.679  0.1157
---

```

```

Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

```

```

Residual standard error: 2.083 on 2 degrees of freedom
Multiple R-squared:  0.7821,    Adjusted R-squared:  0.6731
F-statistic: 7.177 on 1 and 2 DF,  p-value: 0.1157

```

```

Call:
lm(formula = iWUE ~ MeanH, data = data)

```

```

Residuals:
    1      2      3      4
0.1837  2.0893 -3.5963  1.3233

```

```

Coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept)   53.079     30.832   1.722   0.227
MeanH          1.954      1.883   1.037   0.409

```

```

Residual standard error: 3.089 on 2 degrees of freedom
Multiple R-squared:  0.3499,    Adjusted R-squared:  0.02479

```

F-statistic: 1.076 on 1 and 2 DF, p-value: 0.4085

Call:

```
lm(formula = iWUE ~ MeanH, data = data)
```

Residuals:

1	2	3	4
4.101	-6.113	-1.155	3.166

Coefficients:

	Estimate	Std. Error	t value	Pr(> t)
(Intercept)	79.175	22.576	3.507	0.0726 .
MeanH	1.637	1.415	1.157	0.3669

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 5.725 on 2 degrees of freedom

Multiple R-squared: 0.4008, Adjusted R-squared: 0.1012

F-statistic: 1.338 on 1 and 2 DF, p-value: 0.3669

Call:

```
lm(formula = iWUE ~ MeanH, data = data)
```

Residuals:

1	2	3	4	5
5.8476	-3.5099	-3.8033	0.1056	1.3601

Coefficients:

	Estimate	Std. Error	t value	Pr(> t)
(Intercept)	73.70414	8.57593	8.594	0.00331 **
MeanH	-0.09332	0.50719	-0.184	0.86575

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 4.577 on 3 degrees of freedom

Multiple R-squared: 0.01116, Adjusted R-squared: -0.3185

F-statistic: 0.03385 on 1 and 3 DF, p-value: 0.8658

###Relationship between iWUE and basal area (BA) for each forest stand###

	SiteSP (Intercept)	BA
1	AHOA	89.66025 -0.13699832
2	LBSP	40.30052 0.87818324
3	RASP	54.42948 0.56889335
4	SAOA	44.49318 1.93700312
5	THSP	75.24222 0.94186657
6	TUSS	68.55350 0.05475658

Call:

```
lm(formula = iWUE ~ BA, data = data)
```

Residuals:

1	2	3	4	5
0.88236	-1.15633	-5.17155	0.03582	5.40970

Coefficients:

	Estimate	Std. Error	t value	Pr(> t)
(Intercept)	89.660	26.500	3.383	0.043 *
BA	-0.137	1.133	-0.121	0.911

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 4.402 on 3 degrees of freedom

Multiple R-squared: 0.004848, Adjusted R-squared: -0.3269

F-statistic: 0.01462 on 1 and 3 DF, p-value: 0.9114

Call:

```
lm(formula = iWUE ~ BA, data = data)
```

```

Residuals:
    1      2      3      4      5
1.7183 -2.4654  0.5118 -1.5166  1.7519

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)  40.3005    11.9154   3.382  0.0430 *
BA           0.8782     0.2622   3.349  0.0441 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 2.211 on 3 degrees of freedom
Multiple R-squared:  0.7889,    Adjusted R-squared:  0.7186
F-statistic: 11.21 on 1 and 3 DF,  p-value: 0.0441

```

```

Call:
lm(formula = iWUE ~ Basal, data = data)

```

```

Residuals:
    1      2      3      4
-1.3032  2.0534 -0.2663 -0.4839

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)  54.4295     6.8463   7.950  0.0155 *
Basal        0.5689     0.1731   3.287  0.0814 .
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 1.764 on 2 degrees of freedom
Multiple R-squared:  0.8438,    Adjusted R-squared:  0.7657
F-statistic: 10.8 on 1 and 2 DF,  p-value: 0.08142

```

```

Call:
lm(formula = iWUE ~ BA, data = data)

```

```

Residuals:
    1      2      3      4
 0.1193  1.4521 -1.1241 -0.4473

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)  44.493     10.714   4.153  0.0534 .
BA           1.937      0.511   3.791  0.0631 .
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 1.339 on 2 degrees of freedom
Multiple R-squared:  0.8778,    Adjusted R-squared:  0.8167
F-statistic: 14.37 on 1 and 2 DF,  p-value: 0.06308

```

```

Call:
lm(formula = iWUE ~ BA, data = data)

```

```

Residuals:
    1      2      3      4
2.468 -7.839  2.391  2.980

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)  75.2422    36.7585   2.047  0.177
BA           0.9419     1.1561   0.815  0.501

Residual standard error: 6.408 on 2 degrees of freedom
Multiple R-squared:  0.2492,    Adjusted R-squared: -0.1262
F-statistic: 0.6638 on 1 and 2 DF,  p-value: 0.5008

```

```
Call:
lm(formula = iWUE ~ BA, data = data)

Residuals:
    1      2      3      4      5 
6.6275 -2.1959 -3.3401 -0.6054 -0.4861

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept) 68.55350     9.52654   7.196  0.00553 **
BA           0.05476     0.14093   0.389  0.72355
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 4.491 on 3 degrees of freedom
Multiple R-squared:  0.04791, Adjusted R-squared:  -0.2695 
F-statistic: 0.151 on 1 and 3 DF, p-value: 0.7235
```

###Relationship between D180w and mean diameter at breast Height (Mean DBH) for each forest stand###

	SiteSP (Intercept)	Mean DBH
1	AHOA 36.30428	-0.12007985
2	LBSP 30.77911	0.07573824
3	RASP 31.64113	0.02573940
4	SAOA 32.82278	0.02822676
5	THSP 32.02707	0.07334088
6	TUSS 32.01310	0.01545798

```
Call:
lm(formula = D180 ~ Mean DBH, data = data)

Residuals:
    1      2      3      4      5 
-0.124929  0.005487  0.024312  0.384342 -0.289211

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept) 36.30428     1.35969  26.700  0.000115 ***
Mean DBH    -0.12008     0.05454  -2.202  0.114977
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.2873 on 3 degrees of freedom
Multiple R-squared:  0.6177, Adjusted R-squared:  0.4903 
F-statistic: 4.848 on 1 and 3 DF, p-value: 0.115
```

```
Call:
lm(formula = D180 ~ Mean DBH, data = data)

Residuals:
    1      2      3      4      5 
-0.07863  0.11478  0.22420 -0.41776  0.15741

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept) 30.77911     1.75271  17.561  0.000403 ***
Mean DBH     0.07574     0.07753   0.977  0.400683
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.2994 on 3 degrees of freedom
Multiple R-squared:  0.2413, Adjusted R-squared:  -0.01157 
F-statistic: 0.9543 on 1 and 3 DF, p-value: 0.4007
```

```
Call:
lm(formula = D180 ~ Mean DBH, data = data)
```

```

Residuals:
      1      2      3      4
0.07595 0.40638 -0.08873 -0.39361

Coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept) 31.64113    0.51368  61.597 0.000263 ***
Mean DBH     0.02574    0.02155   1.195 0.354704
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.4085 on 2 degrees of freedom
Multiple R-squared:  0.4164,    Adjusted R-squared:  0.1246
F-statistic: 1.427 on 1 and 2 DF,  p-value: 0.3547

```

```

Call:
lm(formula = D180 ~ Mean DBH, data = data)

```

```

Residuals:
      1      2      3      4
0.31336 -0.61050  0.38613 -0.08899

Coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept) 32.82278    2.30870  14.217 0.00491 **
Mean DBH     0.02823    0.09867   0.286 0.80173
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.5603 on 2 degrees of freedom
Multiple R-squared:  0.03931,    Adjusted R-squared: -0.441
F-statistic: 0.08184 on 1 and 2 DF,  p-value: 0.8017

```

```

Call:
lm(formula = D180 ~ Mean DBH, data = data)

```

```

Residuals:
      1      2      3      4
0.3743 -0.5263 -0.1437  0.2958

Coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept) 32.02707    1.76702  18.125 0.00303 **
Mean DBH     0.07334    0.08011   0.916 0.45656
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.5125 on 2 degrees of freedom
Multiple R-squared:  0.2953,    Adjusted R-squared: -0.05701
F-statistic: 0.8382 on 1 and 2 DF,  p-value: 0.4566

```

```

Call:
lm(formula = D180 ~ Mean DBH, data = data)

```

```

Residuals:
      1      2      3      4      5
0.31622 0.06129 -0.46394 -0.25140  0.33783

Coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept) 32.01310    1.06359  30.099 8.06e-05 ***
Mean DBH     0.01546    0.05266   0.294  0.788
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.4067 on 3 degrees of freedom
Multiple R-squared:  0.02792,    Adjusted R-squared: -0.2961
F-statistic: 0.08617 on 1 and 3 DF,  p-value: 0.7882

```

###Relationship between D180w and mean height (Mean H) for each forest stand###

	SiteSP (Intercept)	MeanH
1	AHOA 39.51990	-0.31097296
2	LBSP 30.92613	0.09286409
3	RASP 34.57697	-0.21044745
4	SAOA 32.39876	0.06602950
5	THSP 31.85910	0.11176200
6	TUSS 31.91706	0.02458303

Call:

```
lm(formula = D180 ~ MeanH, data = data)
```

Residuals:

1	2	4	5
-0.1382	0.1684	0.3736	-0.4038

Coefficients:

	Estimate	Std. Error	t value	Pr(> t)
(Intercept)	39.5199	4.8070	8.221	0.0145 *
MeanH	-0.3110	0.2404	-1.293	0.3251

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.4183 on 2 degrees of freedom

(1 observation deleted due to missingness)

Multiple R-squared: 0.4555, Adjusted R-squared: 0.1832

F-statistic: 1.673 on 1 and 2 DF, p-value: 0.3251

Call:

```
lm(formula = D180 ~ MeanH, data = data)
```

Residuals:

1	2	3	4	5
-0.1324	0.1035	0.2759	-0.4076	0.1607

Coefficients:

	Estimate	Std. Error	t value	Pr(> t)
(Intercept)	30.92613	2.03867	15.170	0.000622 ***
MeanH	0.09286	0.12106	0.767	0.498870

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.3143 on 3 degrees of freedom

Multiple R-squared: 0.164, Adjusted R-squared: -0.1147

F-statistic: 0.5884 on 1 and 3 DF, p-value: 0.4989

Call:

```
lm(formula = D180 ~ MeanH, data = data)
```

Residuals:

1	2	3	4
-0.02728	0.02984	0.05177	-0.05432

Coefficients:

	Estimate	Std. Error	t value	Pr(> t)
(Intercept)	34.57697	0.19271	179.43	3.11e-05 ***
MeanH	-0.21045	0.01688	-12.47	0.00637 **

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.06027 on 2 degrees of freedom

Multiple R-squared: 0.9873, Adjusted R-squared: 0.9809

F-statistic: 155.4 on 1 and 2 DF, p-value: 0.006373

Call:

```
lm(formula = D180 ~ MeanH, data = data)

Residuals:
    1      2      3      4 
0.26812 -0.62101  0.42350 -0.07061

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept) 32.39876    5.65461   5.730  0.0291 *
MeanH        0.06603    0.34541   0.191  0.8660
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.5665 on 2 degrees of freedom
Multiple R-squared:  0.01794,    Adjusted R-squared:  -0.4731 
F-statistic: 0.03654 on 1 and 2 DF,  p-value: 0.866
```

```
Call:
lm(formula = D180 ~ MeanH, data = data)

Residuals:
    1      2      3      4 
0.3655 -0.5275 -0.1599  0.3219

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept) 31.8591    2.0509  15.534  0.00412 **
MeanH        0.1118    0.1286   0.869  0.47630
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.5201 on 2 degrees of freedom
Multiple R-squared:  0.2743,    Adjusted R-squared:  -0.08861 
F-statistic: 0.7558 on 1 and 2 DF,  p-value: 0.4763
```

```
Call:
lm(formula = D180 ~ MeanH, data = data)

Residuals:
    1      2      3      4      5 
0.35904  0.09316 -0.44631 -0.25251  0.24662

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept) 31.91706    0.73482  43.435 2.69e-05 ***
MeanH        0.02458    0.04346   0.566  0.611
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.3922 on 3 degrees of freedom
Multiple R-squared:  0.09638,    Adjusted R-squared:  -0.2048 
F-statistic: 0.32 on 1 and 3 DF,  p-value: 0.6112
```

###Relationship between D180w and Basal area (BA) for each forest stand###

	SiteSP (Intercept)	Basal
1	AHOA	34.80516 -0.063519156
2	LBSP	30.96025 0.033701432
3	RASP	35.05797 -0.072754424
4	SAOA	35.21602 -0.083043066
5	THSP	31.30962 0.073184288
6	TUSS	31.80146 0.007857909

```
Call:
lm(formula = D180 ~ BA, data = data)
```

```
Residuals:
    1      2      3      4      5
```

0.18989 0.34623 0.06782 0.04725 -0.65119

Coefficients:

	Estimate	Std. Error	t value	Pr(> t)
(Intercept)	34.80516	2.66260	13.072	0.000967 ***
BA	-0.06352	0.11386	-0.558	0.615861

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.4423 on 3 degrees of freedom

Multiple R-squared: 0.09399, Adjusted R-squared: -0.208

F-statistic: 0.3112 on 1 and 3 DF, p-value: 0.6159

Call:

lm(formula = D180 ~ BA, data = data)

Residuals:

1	2	3	4	5
-0.1073	0.1600	0.2019	-0.4132	0.1586

Coefficients:

	Estimate	Std. Error	t value	Pr(> t)
(Intercept)	30.96025	1.62810	19.016	0.000318 ***
BA	0.03370	0.03583	0.941	0.416329

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.3021 on 3 degrees of freedom

Multiple R-squared: 0.2277, Adjusted R-squared: -0.02971

F-statistic: 0.8846 on 1 and 3 DF, p-value: 0.4163

Call:

lm(formula = D180 ~ BA, data = data)

Residuals:

1	2	3	4
0.01885	0.05210	-0.12704	0.05608

Coefficients:

	Estimate	Std. Error	t value	Pr(> t)
(Intercept)	35.05797	0.41043	85.417	0.000137 ***
BA	-0.07275	0.01038	-7.012	0.019741 *

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.1057 on 2 degrees of freedom

Multiple R-squared: 0.9609, Adjusted R-squared: 0.9414

F-statistic: 49.16 on 1 and 2 DF, p-value: 0.01974

Call:

lm(formula = D180 ~ BA, data = data)

Residuals:

1	2	3	4
0.1286	-0.6611	0.3400	0.1925

Coefficients:

	Estimate	Std. Error	t value	Pr(> t)
(Intercept)	35.21602	4.40484	7.995	0.0153 *
BA	-0.08304	0.21009	-0.395	0.7308

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.5506 on 2 degrees of freedom

Multiple R-squared: 0.07246, Adjusted R-squared: -0.3913

F-statistic: 0.1562 on 1 and 2 DF, p-value: 0.7308

Call:

```
lm(formula = D180 ~ BA, data = data)

Residuals:
    1      2      3      4 
0.2821 -0.6473  0.0944  0.2708 

Coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept) 31.30962    3.09119  10.129  0.00961 **
BA           0.07318    0.09722   0.753  0.53013
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.5389 on 2 degrees of freedom
Multiple R-squared:  0.2208,    Adjusted R-squared:  -0.1688 
F-statistic: 0.5667 on 1 and 2 DF,  p-value: 0.5301
```

```
Call:
lm(formula = D180 ~ BA, data = data)

Residuals:
    1      2      3      4      5 
0.3069  0.1632 -0.4262 -0.2907  0.2467 

Coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept) 31.801465    0.819622  38.800 3.77e-05 ***
BA           0.007858    0.012125   0.648   0.563
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.3864 on 3 degrees of freedom
Multiple R-squared:  0.1228,    Adjusted R-squared:  -0.1696 
F-statistic: 0.42 on 1 and 3 DF,  p-value: 0.5631
```

```
#####
#####Supplementary text S2#####
#####
#####
Output from linear mixed model analyses (LME) for iwUE including soil types and age as
fixed factors. Soil type categories are:arenosol, cambisol, leptosol, podzol, vertisol.
For tree age see table 1 #####
#####
#####
```

```
###Model I: LME with only stand factors###
###Note that none of them turns out as significant predictor###
```

```
Linear mixed-effects model fit by maximum likelihood
```

```
Data: ICP
      AIC      BIC    logLik
1558.428 1590.157 -770.2142
```

```
Random effects:
Formula: ~1 | Site_Sp
(Intercept) Residual
StdDev:    5.425154 7.586495
```

```
Correlation Structure: AR(1)
Formula: ~1 | Site_Sp
Parameter estimate(s):
Phi
0.7553534
```

```
Fixed effects: iwUE ~ Age + SoilType
              Value Std. Error  DF    t-value p-value
(Intercept)  106.25481 11.593161 239   9.165301  0.0000
Age          -0.20421  0.171728   6  -1.189155  0.2793
SoilTypeCambisol -14.79140  8.303224   6  -1.781404  0.1251
SoilTypeleptosol -11.27511  8.285447   6  -1.360832  0.2225
SoilTypepodzol  -13.95455  6.207740   6  -2.247927  0.0656
```

SoilTypevertisol -8.23876 6.414783 6 -1.284340 0.2464

Correlation:

	(Intr)	Age	SlTypC	SlTypL	SlTypp
Age	-0.911				
SoilTypeCambisol	-0.303	0.072			
SoilTypeleptosol	-0.266	0.031	0.335		
SoilTypepodzol	-0.692	0.411	0.473	0.457	
SoilTypevertisol	-0.059	-0.272	0.410	0.422	0.462

Standardized Within-Group Residuals:

Min	Q1	Med	Q3	Max
-3.00459176	-0.63717024	-0.06076653	0.47263708	3.55150303

Number of Observations: 251

Number of Groups: 12

R2m	R2c
0.2123685	0.4788652

###Model II: Model with stand parameters and climate ###

###Slightly lower AIC compared to model I###

###None of the stand parameters turn out as significant predictor###

Linear mixed-effects model fit by maximum likelihood

Data: ICP

AIC	BIC	logLik
1527.165	1572.996	-750.5826

Random effects:

Formula: ~1 | Site_Sp

(Intercept) Residual

StdDev: 2.035874 7.227987

Correlation Structure: AR(1)

Formula: ~1 | Site_Sp

Parameter estimate(s):

Phi

0.7613842

Fixed effects: iwUE ~ PFT + Age + SoilType + pca_s1 + pca_a1 + pca_a3

	Value	Std.Error	DF	t-value	p-value
(Intercept)	86.85412	12.669466	237	6.855389	0.0000
PFTConifer	12.52487	8.263937	4	1.515606	0.2042
Age	-0.07713	0.148826	4	-0.518274	0.6316
SoilTypeCambisol	0.59838	7.282581	4	0.082166	0.9385
SoilTypeleptosol	-7.65834	6.916494	4	-1.107258	0.3303
SoilTypepodzol	-8.85429	5.471761	4	-1.618179	0.1809
SoilTypevertisol	0.17572	5.247793	4	0.033485	0.9749
pca_s1	-2.52740	0.689427	4	-3.665952	0.0215
pca_a1	-0.64567	0.125612	237	-5.140178	0.0000
pca_a3	-0.39759	0.193512	237	-2.054605	0.0410

Correlation:

	(Intr)	PFTCnf	Age	SlTypC	SlTypL	SlTypp	SlTypv	pca_s1	pca_a1
PFTConifer	-0.803								
Age	-0.932	0.666							
SoilTypeCambisol	-0.641	0.601	0.428						
SoilTypeleptosol	-0.612	0.624	0.438	0.527					
SoilTypepodzol	0.070	-0.508	-0.132	0.092	-0.113				
SoilTypevertisol	-0.515	0.588	0.225	0.648	0.602	0.052			
pca_s1	0.050	0.044	0.066	-0.287	0.148	-0.477	-0.156		
pca_a1	-0.006	0.004	0.005	0.003	0.002	0.003	0.005	0.003	
pca_a3	0.001	0.007	0.010	-0.022	-0.011	-0.021	-0.026	-0.004	0.063

Standardized Within-Group Residuals:

Min	Q1	Med	Q3	Max
-2.8163705	-0.6981651	-0.1638104	0.5389805	3.8770525

Number of Observations: 251

Number of Groups: 12

```
#####
#####Supplementary text S3#####
#####
#####
###Output from linear mixed model analyses (LME) for d15N including soil type and age as
fixed factors (see above)#####
#####
```

```
##Including only stand parameters in the model##
##They did not result as significant predictors in the model
```

Linear mixed-effects model fit by maximum likelihood

```
Data: ICP
      AIC      BIC    logLik
535.8694 559.0962 -260.9347
```

Random effects:

```
Formula: ~1 | Site_Sp
      (Intercept) Residual
StdDev:   0.7575852 0.8222457
```

Correlation Structure: AR(1)

```
Formula: ~1 | Site_Sp
Parameter estimate(s):
      Phi
0.1391477
```

Fixed effects: d15N ~ Age + SoilType

	Value	Std.Error	DF	t-value	p-value
(Intercept)	-1.9620422	1.3603287	194	-1.4423295	0.1508
Age	0.0035219	0.0201262	6	0.1749904	0.8668
SoilTypepodzol	1.2170226	0.7292056	6	1.6689705	0.1462
SoilTypevertisol	-0.0299158	0.7522937	6	-0.0397661	0.9696

Correlation:

	(Intr)	Age	SlTypp
Age	-0.911		
SoilTypepodzol	-0.694	0.413	
SoilTypevertisol	-0.062	-0.270	0.463

Standardized Within-Group Residuals:

Min	Q1	Med	Q3	Max
-3.14510897	-0.50460097	-0.04976979	0.56213746	3.51314038

Number of Observations: 204

Number of Groups: 10

R2m	R2c
0.2139443	0.5748536

```
###Adding to the final model presented in the Table 4 soil type and age###
```

```
##Soil parameters were not significant predictors in the model
```

Linear mixed-effects model fit by maximum likelihood

```
Data: ICP
      AIC      BIC    logLik
532.0451 565.2263 -256.0225
```

Random effects:

```
Formula: ~1 | Site_Sp
      (Intercept) Residual
StdDev:   0.434712 0.8221021
```

Correlation Structure: AR(1)

```
Formula: ~1 | Site_Sp
Parameter estimate(s):
      Phi
0.138889
```

Fixed effects: d15N ~ PFT + pca_s1 + sNdep + Age + SoilType

	Value	Std.Error	DF	t-value	p-value
(Intercept)	0.3459480	1.9320438	194	0.1790580	0.8581
PFTConifer	-1.4888226	1.5540633	3	-0.9580192	0.4087
pca_s1	0.3139713	0.2654321	3	1.1828685	0.3221
cNdep	0.0269180	0.1574382	3	0.1709749	0.8751
Age	-0.0136493	0.0179385	3	-0.7608967	0.5021
SoilTypepodzol	0.7145859	0.7686076	3	0.9297148	0.4211
SoilTypevertisol	-0.8542589	1.2731924	3	-0.6709582	0.5503

Correlation:

	(Intr)	PFTCnf	pca_s1	sNdep	Age	SlTyp
PFTConifer	-0.895					
pca_s1	-0.638	0.774				
sNdep	-0.679	0.802	0.956			
Age	-0.888	0.667	0.374	0.374		
SoilTypepodzol	0.444	-0.723	-0.682	-0.597	-0.317	
SoilTypevertisol	-0.777	0.873	0.826	0.887	0.428	-0.510

Standardized Within-Group Residuals:

	Min	Q1	Med	Q3	Max
	-3.10576182	-0.47165075	0.01063984	0.54893861	3.49073614

Number of Observations: 204

Number of Groups: 10

R2m	R2c
0.4460353	0.567083

```
#####
#####Supplementary text S4#####
#####
#####Running linear mixed analyses (LME) for iWUE#####
#####with or without Sitka spruce #####
#####
#####Running LME model for iWUE with Sitka spruce stands included#####
#####
#####All independent variables were centered prior to analysis#####
#####Fixed factors are grouping into conifers and deciduous species (plant functional##
#####type, PFT), site (PCA_s) and time (PCA_a) climate variables from PCA analysis,####
#####changes in atmospheric CO2 (ca), spatial (sSdep, sNdep) and annual (aSdep, aNdep)##
#####changes in sulphur and nitrogen deposition.#####
#####
```

(I) - LME including all the parameters - note that in this case two sites (Covert Wood and Shobdon) were excluded as there are no annual data for Ndep and Sdep, thus the number of sites included in the analyses is 10

Linear mixed-effects model fit by maximum likelihood

Data: ICP

AIC	BIC	logLik
831.1601	872.3431	-401.5801

Random effects:

Formula: ~1 | Site_Sp

(Intercept) Residual

StdDev: 3.624952 4.780661

Correlation Structure: AR(1)

Formula: ~1 | Site_Sp

Parameter estimate(s):

Phi

0.5434811

Fixed effects: iWUE ~ PFT + pca_s1 + pca_a1 + pca_a3 + pca_a2 + sNdep + sSdep + ca + aSdep + aNdep

	Value	Std.Error	DF	t-value	p-value
(Intercept)	80.94442	2.328230	124	34.76651	0.0000
PFTConifer	9.81424	3.209906	5	3.05748	0.0282

pca_s1	-4.87977	1.123633	5	-4.34285	0.0074
pca_a1	-0.67087	0.170074	124	-3.94458	0.0001
pca_a3	-0.46266	0.253914	124	-1.82211	0.0708
pca_a2	-0.10618	0.219463	124	-0.48383	0.6294
sNdep	-0.59900	0.650696	5	-0.92055	0.3995
sSdep	-1.15434	0.450185	5	-2.56415	0.0504
ca	0.03991	0.087205	124	0.45762	0.6480
aSdep	-0.19915	0.193985	124	-1.02664	0.3066
aNdep	0.11062	0.176846	124	0.62551	0.5328

Correlation:

(Intr)	PFTCnf	pca_s1	pca_a1	pca_a3	pca_a2	sNdep	sSdep	ca	aSdep
PFTConifer	-0.764								
pca_s1	0.170	-0.368							
pca_a1	0.068	-0.018	-0.016						
pca_a3	-0.008	-0.004	0.011	0.156					
pca_a2	0.055	-0.010	-0.002	0.153	-0.012				
sNdep	0.025	-0.102	0.767	-0.017	0.012	0.001			
sSdep	0.003	-0.172	0.045	0.001	0.000	-0.019	-0.365		
ca	-0.150	-0.006	-0.003	-0.116	0.199	-0.046	-0.020	0.024	
aSdep	-0.022	-0.003	-0.006	-0.016	0.285	0.105	-0.006	0.007	0.328
aNdep	-0.037	0.003	-0.002	0.067	-0.195	-0.071	-0.012	0.022	0.143
									-0.334

Standardized Within-Group Residuals:

Min	Q1	Med	Q3	Max
-4.2741912	-0.6299001	-0.1422264	0.3886061	2.8677755

Number of Observations: 140

Number of Groups: 10

R2m	R2c
[1,] 0.6600082	0.7841251

##sSdep is the only significant predictor among the atmospheric deposition parameters. We run next model, where we include it together with sNdep and ca, which are available for all sites.

(II) - LME including climate, ca and mean site Sdep and Ndep as they are available for all sites - ref. Methods for details. Note that in this case all 12 sites were included in the model###

Linear mixed-effects model fit by maximum likelihood

Data: ICP

AIC	BIC	logLik
1523.796	1562.575	-750.8978

Random effects:

Formula: ~1 | Site_Sp
(Intercept) Residual
StdDev: 3.544995 6.846698

Correlation Structure: AR(1)

Formula: ~1 | Site_Sp
Parameter estimate(s):
Phi

0.7341624

Fixed effects: iWUE ~ PFT + pca_s1 + pca_a1 + pca_a3 + sSdep + ca + sNdep

	Value	Std.Error	DF	t-value	p-value
(Intercept)	79.67410	2.221875	236	35.85896	0.0000
PFTConifer	9.61270	3.384694	7	2.84005	0.0250
pca_s1	-2.50256	0.751573	7	-3.32976	0.0126
pca_a1	-0.63022	0.126239	236	-4.99228	0.0000
pca_a3	-0.34032	0.196765	236	-1.72960	0.0850
sSdep	-0.60869	0.471488	7	-1.29099	0.2377
ca	0.09443	0.056960	236	1.65778	0.0987
sNdep	0.55355	0.480235	7	1.15267	0.2869

Correlation:

(Intr)	PFTCnf	pca_s1	pca_a1	pca_a3	sSdep	ca
PFTConifer	-0.761					
pca_s1	0.293	-0.385				
pca_a1	0.001	-0.001	0.004			
pca_a3	0.000	0.018	-0.015	0.078		

sSdep	0.265	-0.346	0.074	0.001	-0.010	
ca	0.015	0.001	-0.002	0.093	0.193	-0.007
sNdep	-0.104	0.136	0.416	-0.001	0.011	-0.551 0.002

Standardized Within-Group Residuals:

Min	Q1	Med	Q3	Max
-3.4034691	-0.6107779	-0.1014720	0.5139375	4.3446512

Number of Observations: 251

Number of Groups: 12

	R2m	R2c
[1,]	0.4438774	0.5614461

(III) - LME including only significant predictors from model II (note that we included also ca, even though the significance of the t-test was marginal ($p < 0.1$))

Linear mixed-effects model fit by maximum likelihood

Data: ICP

AIC	BIC	logLik
1521.644	1553.373	-751.8221

Random effects:

Formula: ~1 | Site_Sp
(Intercept) Residual

StdDev: 4.019864 6.914687

Correlation Structure: AR(1)

Formula: ~1 | Site_Sp

Parameter estimate(s):

Phi
0.7400037

Fixed effects: iWUE ~ PFT + pca_s1 + pca_a1 + pca_a3 + ca

	Value	Std.Error	DF	t-value	p-value
(Intercept)	80.37826	2.303004	236	34.90149	0.0000
PFTConifer	8.22713	3.409152	9	2.41325	0.0390
pca_s1	-2.64961	0.674678	9	-3.92723	0.0035
pca_a1	-0.62891	0.125442	236	-5.01359	0.0000
pca_a3	-0.34253	0.195508	236	-1.75201	0.0811
ca	0.09427	0.057403	236	1.64228	0.1019

Correlation:

	(Intr)	PFTCnf	pca_s1	pca_a1	pca_a3
PFTConifer	-0.739				
pca_s1	0.306	-0.414			
pca_a1	0.001	0.000	0.005		
pca_a3	0.002	0.015	-0.020	0.078	
ca	0.017	-0.002	0.000	0.093	0.190

Standardized Within-Group Residuals:

Min	Q1	Med	Q3	Max
-3.14784262	-0.62576137	-0.08920985	0.53041055	4.13068263

Number of Observations: 251

Number of Groups: 12

	R2m	R2c
[1,]	0.4043793	0.5548325

(IV) - LME including only significant predictors from model III. Note that AIC does not significantly change between the two model and from a graphical check (qqplot and residual vs. fitted) we identified the model V as final model and report results in Table 3

Linear mixed-effects model fit by maximum likelihood

Data: ICP

AIC	BIC	logLik
1522.332	1550.536	-753.166

Random effects:

Formula: ~1 | Site_Sp
(Intercept) Residual

StdDev: 3.817686 7.155685

Correlation Structure: AR(1)

Formula: ~1 | Site_Sp

Parameter estimate(s):

Phi

0.7560515

Fixed effects: iWUE ~ PFT + pca_s1 + pca_a1 + pca_a3

	Value	Std.Error	DF	t-value	p-value
(Intercept)	80.32170	2.297150	237	34.96581	0.0000
PFTConifer	8.26064	3.401363	9	2.42863	0.0381
pca_s1	-2.65225	0.673097	9	-3.94037	0.0034
pca_a1	-0.64541	0.124576	237	-5.18086	0.0000
pca_a3	-0.39890	0.191755	237	-2.08024	0.0386

Correlation:

(Intr) PFTCnf pca_s1 pca_a1

PFTConifer -0.739

pca_s1 0.306 -0.415

pca_a1 -0.001 0.000 0.005

pca_a3 0.000 0.016 -0.020 0.063

Standardized Within-Group Residuals:

Min	Q1	Med	Q3	Max
-2.83630783	-0.63549362	-0.07008074	0.53404497	3.70035282

Number of Observations: 251

Number of Groups: 12

R2m R2c

[1,] 0.385148 0.5213824

#####LME analyses for iWUE without the two Sitka spruce forest stands#####
#####

(I) - LME including all the parameters - note that in this case other two sites (Covert wood and Shobdon were excluded as there are no annual data for Ndep and Sdep, thus number of sites is 8

Linear mixed-effects model fit by maximum likelihood

Data: ICP1

AIC	BIC	logLik
671.6546	707.3387	-322.8273

Random effects:

Formula: ~1 | Site_Sp

(Intercept) Residual

StdDev: 1.916131 4.34939

Correlation Structure: AR(1)

Formula: ~1 | Site_Sp

Parameter estimate(s):

Phi

0.4562544

Fixed effects: iWUE ~ PFT + pca_s1 + pca_a1 + pca_a3 + sNdep + sSdep + ca + aSdep + aNdep

	Value	Std.Error	DF	t-value	p-value
(Intercept)	81.73211	1.4989504	102	54.52623	0.0000
PFTConifer	8.83246	2.0881530	3	4.22979	0.0242
pca_s1	-4.76488	0.7154376	3	-6.66010	0.0069
pca_a1	-0.64135	0.1852927	102	-3.46129	0.0008
pca_a3	-0.50598	0.2833109	102	-1.78594	0.0771
sNdep	-0.85590	0.4095735	3	-2.08973	0.1278
sSdep	-1.57566	0.3267597	3	-4.82208	0.0170
ca	0.06280	0.0860291	102	0.73001	0.4671
aSdep	-0.42827	0.2205622	102	-1.94171	0.0549
aNdep	0.08525	0.2083621	102	0.40914	0.6833

Correlation:

(Intr) PFTCnf pca_s1 pca_a1 pca_a3 sNdep sSdep ca aSdep

PFTConifer -0.713

pca_s1 0.172 -0.286

```

pca_a1      0.093 -0.028 -0.028
pca_a3     -0.022  0.002  0.025  0.036
sNdep      -0.006 -0.082  0.729 -0.035  0.023
sSdep      -0.032  0.004  0.105  0.004  0.001 -0.273
ca         -0.240 -0.014 -0.016 -0.130  0.233 -0.016  0.030
aSdep      -0.074 -0.003 -0.009 -0.120  0.309 -0.001  0.013  0.407
aNdep      -0.045 -0.004 -0.014  0.182 -0.254 -0.023  0.024  0.140 -0.303

```

```

Standardized Within-Group Residuals:
      Min      Q1      Med      Q3      Max
-4.66233898 -0.60772496 -0.02984588  0.53163164  2.55540289

```

Number of Observations: 115

Number of Groups: 8

```

      R2m      R2c
[1,] 0.7624201 0.8010361

```

(II) – LME including only significant predictors from model I – note that in this case two sites (Covert wood and Shobdon were excluded as there are no annual data for Ndep and Sdep###

Linear mixed-effects model fit by maximum likelihood

Data: ICP1

```

      AIC      BIC      logLik
669.7837 697.233 -324.8918

```

Random effects:

```

Formula: ~1 | Site_Sp
(Intercept) Residual

```

```

StdDev:      2.848908 4.401308

```

Correlation Structure: AR(1)

Formula: ~1 | Site_Sp

Parameter estimate(s):

Phi

0.4740037

Fixed effects: iWUE ~ PFT + pca_s1 + pca_a1 + pca_a3 + sSdep + aSdep

```

      Value Std.Error DF t-value p-value
(Intercept) 81.94220 1.8561987 104 44.14517 0.0000
PFTConifer   8.51365 2.6606580   4  3.19983 0.0329
pca_s1       -3.67297 0.6278045   4 -5.85049 0.0043
pca_a1       -0.65739 0.1769312 104 -3.71548 0.0003
pca_a3       -0.52836 0.2586283 104 -2.04293 0.0436
sSdep        -1.77234 0.4016351   4 -4.41280 0.0116
aSdep        -0.46875 0.1828481 104 -2.56359 0.0118

```

Correlation:

```

      (Intr) PFTCnf pca_s1 pca_a1 pca_a3 sSdep
PFTConifer -0.741
pca_s1      0.267 -0.335
pca_a1      0.054 -0.026 -0.005
pca_a3      0.026  0.005  0.014  0.141
sSdep       -0.029 -0.022  0.463 -0.004  0.005
aSdep       0.020  0.002 -0.007  0.011  0.150  0.007

```

```

Standardized Within-Group Residuals:
      Min      Q1      Med      Q3      Max
-4.80905073 -0.55718676 -0.08022529  0.49331243  2.72094981

```

Number of Observations: 115

Number of Groups: 8

```

      R2m      R2c
[1,] 0.7115607 0.7967277

```

##We report this model to table 3 as it is the final model where we consider all the atmospheric deposition parameters but a subset of sites (8)

(III) – LME including climate, ca and mean site Sdep and Ndep – ref. Methods for details. Note that in this case all sites were included in the model###

Linear mixed-effects model fit by maximum likelihood

Data: ICP1

AIC	BIC	logLik
1250.443	1287.261	-614.2214

Random effects:

Formula: ~1 | Site_Sp
(Intercept) Residual
StdDev: 4.240935 4.950081

Correlation Structure: AR(1)

Formula: ~1 | Site_Sp
Parameter estimate(s):
Phi

0.5022159

Fixed effects: iwUE ~ PFT + pca_s1 + pca_a1 + pca_a3 + sSdep + ca + sNdep

	Value	Std.Error	DF	t-value	p-value
(Intercept)	79.60692	2.118270	197	37.58110	0.0000
PFTConifer	8.90344	3.302905	5	2.69564	0.0430
pca_s1	-2.24491	0.735729	5	-3.05127	0.0284
pca_a1	-0.64768	0.140796	197	-4.60014	0.0000
pca_a3	-0.29698	0.216652	197	-1.37077	0.1720
sSdep	-1.00102	0.496226	5	-2.01726	0.0997
ca	0.18511	0.039994	197	4.62836	0.0000
sNdep	0.50966	0.465300	5	1.09534	0.3233

Correlation:

	(Intr)	PFTCnf	pca_s1	pca_a1	pca_a3	cSdep	cca
PFTConifer	-0.691						
pca_s1	0.316	-0.333					
pca_a1	0.003	-0.004	0.004				
pca_a3	-0.006	0.018	-0.013	0.025			
cSdep	0.270	-0.187	0.059	0.002	-0.007		
cca	0.003	0.005	-0.004	0.087	0.312	-0.002	
cNdep	-0.137	0.088	0.326	-0.003	0.010	-0.512	0.003

Standardized Within-Group Residuals:

	Min	Q1	Med	Q3	Max
	-4.64679468	-0.48380988	0.03740803	0.49086925	2.92905619

Number of Observations: 210

Number of Groups: 10

	R2m	R2c
[1,]	0.5195157	0.7229048

###(IV)- Model with only significant predictors from model III

Fixed effects: iwUE ~ PFT + pca_s1 + pca_a1 + pca_a3 + cSdep + cca

	Value	Std.Error	DF	t-value	p-value
(Intercept)	79.92494	2.219816	197	36.00520	0.0000
PFTConifer	8.58614	3.480678	6	2.46680	0.0487
pca_s1	-2.50803	0.735687	6	-3.40910	0.0143
pca_a1	-0.64704	0.140430	197	-4.60758	0.0000
pca_a3	-0.29899	0.216085	197	-1.38365	0.1680
cSdep	-0.72263	0.450912	6	-1.60260	0.1601
cca	0.18504	0.039917	197	4.63549	0.0000

Correlation:

	(Intr)	PFTCnf	pca_s1	pca_a1	pca_a3	cSdep
PFTConifer	-0.688					
pca_s1	0.385	-0.385				
pca_a1	0.002	-0.003	0.005			
pca_a3	-0.004	0.016	-0.016	0.025		
cSdep	0.235	-0.166	0.279	0.001	-0.002	
cca	0.003	0.005	-0.004	0.087	0.312	-0.001

Standardized Within-Group Residuals:

	Min	Q1	Med	Q3	Max
--	-----	----	-----	----	-----

-4.54984028 -0.49875782 0.04443618 0.45688679 2.99527689

Number of Observations: 210

Number of Groups: 10

R2m R2c
[1,] 0.4896893 0.7228353

##(V)- Only significant predictors from model IV

Linear mixed-effects model fit by maximum likelihood

Data: ICP1

AIC BIC logLik
1249.935 1276.712 -616.9676

Random effects:

Formula: ~1 | Site_Sp
(Intercept) Residual

StdDev: 5.209536 4.953168

Correlation Structure: AR(1)

Formula: ~1 | Site_Sp

Parameter estimate(s):

Phi
0.4964552

Fixed effects: iWUE ~ PFT + pca_s1 + pca_a1 + cca

	Value	Std.Error	DF	t-value	p-value
(Intercept)	80.74806	2.420876	198	33.35489	0.0000
PFTConifer	7.73597	3.850666	7	2.00900	0.0845
pca_s1	-2.19373	0.792610	7	-2.76772	0.0278
pca_a1	-0.64295	0.140658	198	-4.57097	0.0000
cca	0.20184	0.037579	198	5.37106	0.0000

Correlation:

	(Intr)	PFTCnf	pca_s1	pca_a1
PFTConifer	-0.677			
pca_s1	0.342	-0.357		
pca_a1	0.002	-0.003	0.005	
cca	0.004	0.000	0.000	0.083

Standardized Within-Group Residuals:

	Min	Q1	Med	Q3	Max
	-4.63255108	-0.48178546	0.05014027	0.45878382	2.95503274

Number of Observations: 210

Number of Groups: 10

R2m R2c
[1,] 0.4162629 0.7228476

##This is the final model shown in Table 3##

#####Supplementary text S5#####

#####Running linear mixed model analyses (LME) for D180#####
#####with or without Sitka spruce as shown for iWUE in Table 3#####

#####Running LME model for D180 with all sites#####

#####All independent variables were centered prior to analysis#####
#####Fixed factors are: grouping into conifers and deciduous species (plant functional##
#####type, PFT), site (PCA_s) and time (PCA_a) climate variables from PCA analysis,####
#####changes in atmospheric CO2 (ca), spatial (sSdep, sNdep) and annual (aSdep, aNdep)##
#####changes in sulphur and nitrogen deposition.#####
#####

(I) - LME including all the parameters - note that in this case other two sites (Covert Wood and Shobdon were excluded as there are no annual data for Ndep and Sdep##

Linear mixed-effects model fit by maximum likelihood

Data: ICP

```

      AIC      BIC    logLik
132.5909 173.7739 -52.29547

Random effects:
Formula: ~1 | Site_Sp
      (Intercept)  Residual
StdDev:  0.06920099 0.3499774

Correlation Structure: AR(1)
Formula: ~1 | Site_Sp
Parameter estimate(s):
      Phi
0.1325319
Fixed effects: (D180_MB) ~ pca_s1 + pca_a1 + pca_a2 + pca_a3 + ca + PFT + sNdep +
sSdep + aNdep + aSdep
      Value Std.Error DF t-value p-value
(Intercept) 33.09225 0.07350397 124 450.2103 0.0000
pca_s1      -0.28595 0.03328881 5 -8.5901 0.0004
pca_a1      -0.05307 0.01607738 124 -3.3006 0.0013
pca_a2       0.12540 0.02186068 124 5.7364 0.0000
pca_a3       0.04853 0.02496528 124 1.9438 0.0542
ca          -0.00331 0.00584726 124 -0.5668 0.5719
PFTConifer  -0.03618 0.09531956 5 -0.3796 0.7199
sNdep        -0.03650 0.01930717 5 -1.8906 0.1173
sSdep        -0.09380 0.01338924 5 -7.0056 0.0009
aNdep        -0.00399 0.01537827 124 -0.2597 0.7956
aSdep        -0.03362 0.01754163 124 -1.9166 0.0576
Correlation:
      (Intr) pca_s1 pca_a1 pca_a2 pca_a3 ca PFTCnf sNdep sSdep aNdep
pca_s1      0.140
pca_a1      0.173 -0.048
pca_a2      0.128 -0.008 0.138
pca_a3     -0.068 0.021 0.041 0.011
ca          -0.319 0.010 -0.230 0.053 0.347
PFTConifer -0.728 -0.348 -0.059 -0.032 -0.006 -0.005
sNdep       0.008 0.765 -0.056 0.009 0.043 -0.011 -0.089
sSdep      -0.012 0.044 -0.021 -0.079 -0.016 0.030 -0.165 -0.363
aNdep      -0.068 -0.008 0.082 -0.108 -0.133 0.154 -0.004 -0.025 0.027
aSdep      -0.142 0.004 -0.171 0.174 0.178 0.514 -0.003 0.000 0.004 -0.289

Standardized Within-Group Residuals:
      Min      Q1      Med      Q3      Max
-2.45875536 -0.75755997 -0.09984885 0.72881630 2.26196537

Number of Observations: 140
Number of Groups: 10

      R2m      R2c
[1,] 0.2549247 0.483594

###(II)- Removing n.s. predictors###

Linear mixed-effects model fit by maximum likelihood
Data: ICP
      AIC      BIC    logLik
130.2516 162.6097 -54.1258

Random effects:
Formula: ~1 | Site_Sp
      (Intercept)  Residual
StdDev:  0.1068585 0.3494237

Correlation Structure: AR(1)
Formula: ~1 | Site_Sp
Parameter estimate(s):
      Phi
0.1177972
Fixed effects: (D180_MB) ~ pca_s1 + pca_a1 + pca_a2 + pca_a3 + sSdep + PFT +
      Value Std.Error DF t-value p-value

```

```

(Intercept) 33.07803 0.08104600 126 408.1390 0.0000
pca_s1      -0.23807 0.02507908 6 -9.4926 0.0001
pca_a1      -0.05647 0.01537207 126 -3.6735 0.0004
pca_a2      0.12568 0.02150866 126 5.8434 0.0000
pca_a3      0.05466 0.02275689 126 2.4021 0.0178
sSdep       -0.10268 0.01459597 6 -7.0345 0.0004
PFTConifer -0.05259 0.11117426 6 -0.4731 0.6529
aSdep       -0.02927 0.01335548 126 -2.1916 0.0302
Correlation:
      (Intr) pca_s1 pca_a1 pca_a2 pca_a3 sSdep PFTCnf
pca_s1 0.234
pca_a1 0.097 -0.002
pca_a2 0.130 -0.020 0.173
pca_a3 0.038 -0.026 0.163 -0.032
sSdep 0.004 0.539 -0.035 -0.070 -0.007
PFTConifer -0.773 -0.443 -0.058 -0.027 -0.001 -0.218
aSdep 0.016 -0.002 -0.014 0.135 -0.110 -0.006 -0.002

```

```

Standardized Within-Group Residuals:
      Min      Q1      Med      Q3      Max
-2.6528844 -0.6794309 -0.0438899 0.7180382 2.3333909

```

```

Number of Observations: 140
Number of Groups: 10

```

```

      R2m      R2c
[1,] 0.7234077 0.7470628

```

###This is the final model including all parameters (but not all sites) included in Table 4

(III) – LME including climate, ca and mean site Sdep and Ndep – ref. Methods for details. Note that in this case all 12 sites were included in the model###

Linear mixed-effects model fit by maximum likelihood

```

Data: ICP
      AIC      BIC    logLik
301.5035 343.8089 -138.7517

```

Random effects:

```

Formula: ~1 | Site_Sp
      (Intercept) Residual
StdDev: 0.3308475 0.4101382

```

Correlation Structure: AR(1)

```

Formula: ~1 | Site_Sp
Parameter estimate(s):
      Phi
0.2424023

```

Fixed effects: (D180_MB) ~ pca_s1 + pca_a1 + pca_a2 + pca_a3 + cSdep + cNdep + cca + PFT

```

      Value Std.Error DF t-value p-value
(Intercept) 32.85310 0.15855381 235 207.20472 0.0000
pca_s1      -0.08325 0.05363317 7 -1.55223 0.1645
pca_a1      -0.05072 0.01302027 235 -3.89528 0.0001
pca_a2      0.10799 0.01613795 235 6.69153 0.0000
pca_a3      0.06401 0.02086089 235 3.06848 0.0024
cSdep       -0.06635 0.03361350 7 -1.97404 0.0890
cNdep       0.06487 0.03427151 7 1.89283 0.1003
cca         0.00300 0.00267994 235 1.11988 0.2639
PFTConifer 0.00125 0.24149181 7 0.00520 0.9960

```

```

Correlation:
      (Intr) pca_s1 pca_a1 pca_a2 pca_a3 sSdep sNdep ca
pca_s1 0.293
pca_a1 0.004 0.003
pca_a2 -0.007 -0.003 0.006
pca_a3 -0.012 -0.015 0.045 0.052

```

sSdep	0.265	0.074	0.004	-0.003	-0.011		
sNdep	-0.104	0.416	-0.004	-0.001	0.013	-0.551	
cca	-0.005	-0.006	0.063	0.087	0.463	-0.008	0.006
PFTConifer	-0.761	-0.385	-0.006	0.002	0.019	-0.348	0.136 0.007

Standardized Within-Group Residuals:

	Min	Q1	Med	Q3	Max
	-3.41833526	-0.61578859	-0.03462599	0.65145417	2.43992310

Number of Observations: 251
Number of Groups: 12

	R2m	R2c
[1,]	0.3950397	0.6335177

Linear mixed-effects model fit by maximum likelihood

Data: ICP

AIC	BIC	logLik
301.5035	343.8089	-138.7517

Random effects:

Formula: ~1 | Site_Sp
(Intercept) Residual
StdDev: 0.3308475 0.4101382

Correlation Structure: AR(1)

Formula: ~1 | Site_Sp
Parameter estimate(s):
Phi

0.2424023

Fixed effects: (D180_MB) ~ pca_s1 + pca_a1 + pca_a2 + pca_a3 + cSdep + cNdep + cca + PFT

	Value	Std.Error	DF	t-value	p-value
(Intercept)	32.85310	0.15855381	235	207.20472	0.0000
pca_s1	-0.08325	0.05363317	7	-1.55223	0.1645
pca_a1	-0.05072	0.01302027	235	-3.89528	0.0001
pca_a2	0.10799	0.01613795	235	6.69153	0.0000
pca_a3	0.06401	0.02086089	235	3.06848	0.0024
cSdep	-0.06635	0.03361350	7	-1.97404	0.0890
cNdep	0.06487	0.03427151	7	1.89283	0.1003
cca	0.00300	0.00267994	235	1.11988	0.2639
PFTConifer	0.00125	0.24149181	7	0.00520	0.9960

Correlation:

	(Intr)	pca_s1	pca_a1	pca_a2	pca_a3	cSdep	cNdep	cca
pca_s1	0.293							
pca_a1	0.004	0.003						
pca_a2	-0.007	-0.003	0.006					
pca_a3	-0.012	-0.015	0.045	0.052				
cSdep	0.265	0.074	0.004	-0.003	-0.011			
cNdep	-0.104	0.416	-0.004	-0.001	0.013	-0.551		
cca	-0.005	-0.006	0.063	0.087	0.463	-0.008	0.006	
PFTConifer	-0.761	-0.385	-0.006	0.002	0.019	-0.348	0.136	0.007

Standardized Within-Group Residuals:

	Min	Q1	Med	Q3	Max
	-3.41833526	-0.61578859	-0.03462599	0.65145417	2.43992310

Number of Observations: 251
Number of Groups: 12

	R2m	R2c
[1,]	0.3950397	0.6335177

##(IV)- Significant predictors from III###

Linear mixed-effects model fit by maximum likelihood

Data: ICP

AIC	BIC	logLik
302.0017	337.2562	-141.0008

Random effects:
 Formula: ~1 | Site_Sp
 (Intercept) Residual
 StdDev: 0.3834513 0.412155

Correlation Structure: AR(1)
 Formula: ~1 | Site_Sp
 Parameter estimate(s):
 Phi
 0.2497009

Fixed effects: (D180_MB) ~ pca_s1 + pca_a1 + pca_a2 + pca_a3 + sSdep + PFT

	Value	Std.Error	DF	t-value	p-value
(Intercept)	32.88463	0.17974915	236	182.94735	0.0000
pca_s1	-0.12495	0.05559784	8	-2.24731	0.0548
pca_a1	-0.05136	0.01295672	236	-3.96400	0.0001
pca_a2	0.10629	0.01605815	236	6.61908	0.0000
pca_a3	0.05282	0.01846147	236	2.86114	0.0046
sSdep	-0.03112	0.03196711	8	-0.97348	0.3588
PFTConifer	-0.06228	0.27268060	8	-0.22839	0.8251

Correlation:

	(Intr)	pca_s1	pca_a1	pca_a2	pca_a3	cSdep
pca_s1	0.372					
pca_a1	0.004	0.005				
pca_a2	-0.006	-0.002	0.001			
pca_a3	-0.009	-0.017	0.018	0.014		
cSdep	0.250	0.399	0.002	-0.003	-0.002	
PFTConifer	-0.758	-0.490	-0.005	0.001	0.014	-0.330

Standardized Within-Group Residuals:

	Min	Q1	Med	Q3	Max
	-3.55425663	-0.61987511	-0.04165077	0.61410939	2.41069344

Number of Observations: 251
 Number of Groups: 12

R2m R2c
 [1,] 0.3157569 0.6332246

###Model shown in Table 4####

 #####Running LME model for D180w without Sitka spruce stands#####
 #####

(I) - LME including all the parameters - note that in this case other two sites (Covert Wood and Shobdon were excluded as there are no annual data for Ndep and Sdep###

Linear mixed-effects model fit by maximum likelihood

Data: ICP1
 AIC BIC logLik
 119.6407 158.0697 -45.82034

Random effects:
 Formula: ~1 | Site_Sp
 (Intercept) Residual
 StdDev: 1.908737e-05 0.362326

Correlation Structure: AR(1)
 Formula: ~1 | Site_Sp
 Parameter estimate(s):
 Phi

0.1063304

Fixed effects: (D180_MB) ~ pca_s1 + pca_a1 + pca_a2 + pca_a3 + ca + PFT + sNdep + sSdep + aNdep + aSdep

	Value	Std.Error	DF	t-value	p-value
(Intercept)	33.10670	0.06661689	101	496.9715	0.0000
pca_s1	-0.27045	0.02886329	3	-9.3699	0.0026
pca_a1	-0.05935	0.01876551	101	-3.1629	0.0021
pca_a2	0.12741	0.02458774	101	5.1818	0.0000

```

pca_a3      0.04584 0.02909066 101  1.5758  0.1182
ca          -0.00304 0.00669826 101 -0.4540  0.6508
PFTConifer  0.00620 0.08459136  3  0.0733  0.9462
sNdep       -0.04017 0.01656908  3 -2.4243  0.0938
sSdep       -0.08605 0.01328243  3 -6.4788  0.0075
aNdep       -0.00225 0.01963080 101 -0.1144  0.9092
aSdep       -0.02693 0.02167651 101 -1.2422  0.2170
Correlation:
(Intr) pca_s1 pca_a1 pca_a2 pca_a3 cca    PFTCnf sNdep  sSdep  aNdep
pca_s1      0.136
pca_a1      0.212 -0.061
pca_a2      0.134 -0.008  0.132
pca_a3     -0.082  0.046 -0.046  0.056
cca         -0.414 -0.006 -0.225  0.111  0.346
PFTConifer -0.660 -0.265 -0.075 -0.036  0.011 -0.013
sNdep       -0.026  0.733 -0.088  0.014  0.065  0.008 -0.064
sSdep       -0.048  0.105 -0.024 -0.080 -0.011  0.033  0.013 -0.268
aNdep       -0.078 -0.028  0.182 -0.103 -0.193  0.141 -0.019 -0.042  0.025
aSdep       -0.205  0.001 -0.218  0.210  0.216  0.551 -0.003  0.018  0.005 -0.291

```

```

Standardized Within-Group Residuals:
      Min      Q1      Med      Q3      Max
-2.66802776 -0.73130841 -0.04943957  0.72786789  2.11766886

```

Number of Observations: 115

Number of Groups: 8

```

      R2m      R2c
[1,] 0.7002795 0.7002795

```

#Because among the atmospheric deposition parameters sSdep and sNdep ($p < 0.1$) are significant predictors in the model, we can now run the model with Cover Wood and Shodden (but without the two Sitka spruce stands) and including those two parameters and ca again.

(III) - LME including climate, ca and mean site Sdep and Ndep - ref. Methods for details. Note that in this case all sites were included in the model###

Linear mixed-effects model fit by maximum likelihood

```

Data: ICP1
      AIC      BIC    logLik
277.7234 314.5416 -127.8617

```

Random effects:

```

Formula: ~1 | Site_Sp
(Intrcpt) Residual

```

StdDev: 0.3438366 0.4374529

Correlation Structure: AR(1)

```

Formula: ~1 | Site_Sp
Parameter estimate(s):
Phi

```

0.2662285

Fixed effects: (D180_MB) ~ pca_s1 + pca_a1 + pca_a2 + PFT + sSdep + ca + sNdep

```

      Value Std.Error DF   t-value p-value
(Intercept) 32.88029 0.16805620 197 195.65057 0.0000
pca_s1      -0.07574 0.05836531  5  -1.29765 0.2510
pca_a1      -0.05378 0.01496489 197  -3.59373 0.0004
pca_a2      0.10026 0.01839205 197  5.45143 0.0000
PFTConifer  0.06400 0.26200107  5   0.24427 0.8167
sSdep       -0.04711 0.03936761  5  -1.19668 0.2851
ca          -0.00136 0.00281787 197  -0.48199 0.6303
sNdep       0.05771 0.03691334  5   1.56329 0.1787

```

Correlation:

```

(Intr) pca_s1 pca_a1 pca_a2 PFTCnf cSdep  cca
pca_s1      0.316
pca_a1      0.006  0.005
pca_a2     -0.007 -0.003  0.017
PFTConifer -0.691 -0.333 -0.007  0.001
cSdep       0.270  0.059  0.004 -0.001 -0.187
cca         0.001  0.000  0.081  0.091 -0.001  0.000

```

cNdep -0.137 0.327 -0.005 -0.001 0.088 -0.512 -0.001

Standardized Within-Group Residuals:

	Min	Q1	Med	Q3	Max
	-3.47849323	-0.61362152	-0.06562452	0.60421418	2.44706786

Number of Observations: 210

Number of Groups: 10

	R2m	R2c
[1,]	0.2954597	0.5645048

###(IV)- Final model: including only significant predictors (but keeping PFT)###

Linear mixed-effects model fit by maximum likelihood

Data: ICP1

	AIC	BIC	logLik
	274.8804	298.3101	-130.4402

Random effects:

Formula: ~1 | Site_Sp
(Intercept) Residual

StdDev: 0.4504732 0.437895

Correlation Structure: AR(1)

Formula: ~1 | Site_Sp

Parameter estimate(s):

Phi
0.2674578

Fixed effects: (D180_MB) ~ pca_a1 + pca_a2 + PFT

	Value	Std.Error	DF	t-value	p-value
(Intercept)	33.03718	0.19254361	198	171.58285	0.0000
pca_a1	-0.05284	0.01477602	198	-3.57609	0.0004
pca_a2	0.10092	0.01814914	198	5.56064	0.0000
PFTConifer	-0.16256	0.30443495	8	-0.53399	0.6079

Correlation:

	(Intr)	pca_a1	pca_a2
pca_a1		0.002	
pca_a2	-0.005		0.010
PFTConifer	-0.632	-0.004	0.000

Standardized Within-Group Residuals:

	Min	Q1	Med	Q3	Max
	-3.38748909	-0.63405022	-0.06133657	0.60555201	2.51874803

Number of Observations: 210

Number of Groups: 10

	R2m	R2c
[1,]	0.1049902	0.5651648

##Results shown in Table 4

#####Supplementary text S6#####

#####Running linear mixed model analyses (LME) for d15Nw #####
#####with or without Sitka spruce as shown for iWUE in Table 3#####

#####Running LME model for d15Nw with all sites#####

##All independent variables were centered prior to analysis#####
##Fixed factors are: grouping into conifers and deciduous species (plant functional##
##type, PFT), site (PCA_s) and time (PCA_a) climate variables from PCA analysis,####
##changes in atmospheric CO2 (ca), spatial (sSdep, sNdep) and annual (aSdep, aNdep)##
##changes in sulphur and nitrogen deposition.#####
#####

##Model I:Including Ndep and ca

Linear mixed-effects model fit by maximum likelihood

Data: ICP

AIC	BIC	logLik
365.1545	397.1125	-171.5772

Random effects:

Formula: ~1 | Site_Sp
(Intercept) Residual

StdDev: 0.5010163 0.8069796

Correlation Structure: AR(1)

Formula: ~1 | Site_Sp

Parameter estimate(s):

Phi

0.01489395

Fixed effects: d15N ~ PFT + pca_s1 + pca_a1 + pca_a3 + sNdep + ca + aNdep

	Value	Std.Error	DF	t-value	p-value
(Intercept)	-1.1676464	0.2976503	121	-3.922880	0.0001
PFTConifer	-0.0080672	0.4065566	6	-0.019843	0.9848
pca_s1	0.5219081	0.1450911	6	3.597107	0.0114
pca_a1	0.0275127	0.0364118	121	0.755598	0.4514
pca_a3	-0.0341881	0.0592770	121	-0.576751	0.5652
sNdep	0.1402738	0.0778560	6	1.801709	0.1217
ca	0.0025633	0.0111209	121	0.230496	0.8181
aNdep	0.0498688	0.0338781	121	1.472008	0.1436

Correlation:

	(Intr)	PFTCnf	pca_s1	pca_a1	pca_a3	sNdep	ca
PFTConifer	-0.775						
pca_s1	0.173	-0.370					
pca_a1	0.069	-0.035	-0.033				
pca_a3	-0.027	-0.007	0.013	0.034			
sNdep	0.029	-0.184	0.842	-0.040	0.024		
ca	-0.142	-0.011	0.021	-0.179	0.359	0.008	
aNdep	-0.054	0.003	-0.003	0.021	-0.054	-0.011	0.370

Standardized Within-Group Residuals:

Min	Q1	Med	Q3	Max
-3.46885140	-0.47156397	0.03307331	0.52236707	3.35851437

Number of Observations: 135

Number of Groups: 10

R2m	R2c
0.4269688	0.5863962

##Model II - Including only Ndep and climate##

Linear mixed-effects model fit by maximum likelihood

Data: ICP

AIC	BIC	logLik
363.2108	392.2636	-171.6054

Random effects:

Formula: ~1 | Site_Sp
(Intercept) Residual

StdDev: 0.4997899 0.8072875

Correlation Structure: AR(1)

Formula: ~1 | Site_Sp

Parameter estimate(s):

Phi

0.01486507

Fixed effects: d15Nw ~ PFT + pca_s1 + pca_a1 + pca_a3 + sNdep + aNdep

	Value	Std.Error	DF	t-value	p-value
(Intercept)	-1.1579609	0.2929146	122	-3.953238	0.0001
PFTConifer	-0.0070109	0.4041325	6	-0.017348	0.9867

pca_s1	0.5212056	0.1442051	6	3.614336	0.0112
pca_a1	0.0290085	0.0356956	122	0.812664	0.4180
pca_a3	-0.0390784	0.0551386	122	-0.708730	0.4798
sNdep	0.1401286	0.0773933	6	1.810603	0.1202
aNdep	0.0469797	0.0313607	122	1.498047	0.1367

Correlation:

	(Intr)	PFTCnf	pca_s1	pca_a1	pca_a3	sNdep
PFTConifer	-0.784					
pca_s1	0.177	-0.369				
pca_a1	0.045	-0.038	-0.029			
pca_a3	0.026	-0.004	0.005	0.107		
sNdep	0.030	-0.184	0.842	-0.040	0.022	
aNdep	-0.002	0.008	-0.011	0.096	-0.215	-0.015

Standardized Within-Group Residuals:

	Min	Q1	Med	Q3	Max
	-3.46237417	-0.46684484	0.02857387	0.52224830	3.36094193

Number of Observations: 135

Number of Groups: 10

###Model II: Including only significant predictor from model II and including Ndep level as fixed factor. Ndep_lev = low and high Ndep based on the critical loads for the UK (see Methods for more details)###

Linear mixed-effects model fit by maximum likelihood

Data: ICP

AIC	BIC	logLik
528.4263	551.6531	-257.2131

Random effects:

Formula: ~1 | Site_Sp
(Intercept) Residual

StdDev: 0.5006242 0.8222125

Correlation Structure: AR(1)

Formula: ~1 | Site_Sp

Parameter estimate(s):

Phi

0.139253

Fixed effects: d15Nw ~ PFT + pca_s1 + Ndep_lev

	Value	Std.Error	DF	t-value	p-value
(Intercept)	-0.7811910	0.4455136	194	-1.753462	0.0811
PFTConifer	-0.1538184	0.4238945	6	-0.362870	0.7291
pca_s1	0.4169451	0.1110545	6	3.754419	0.0095
Ndep_levlow	-0.7356892	0.5097808	6	-1.443148	0.1991

Correlation:

	(Intr)	PFTCnf	pca_s1
PFTConifer	-0.776		
pca_s1	0.688	-0.553	
Ndep_levlow	-0.769	0.406	-0.734

Standardized Within-Group Residuals:

	Min	Q1	Med	Q3	Max
	-3.023122900	-0.498834107	-0.004658464	0.553191587	3.488135933

Number of Observations: 204

Number of Groups: 10

###Model III: Including only Years x Ndep level as fixed factor###

Linear mixed-effects model fit by maximum likelihood

Data: ICP

AIC	BIC	logLik
530.6807	553.9075	-258.3404

Random effects:
 Formula: ~1 | Site_Sp
 (Intercept) Residual
 StdDev: 0.90135 0.7981379

Correlation Structure: AR(1)
 Formula: ~1 | Site_Sp
 Parameter estimate(s):
 Phi
 0.08978218

Fixed effects: d15Nw ~ Years * Ndep_lev

	Value	Std.Error	DF	t-value	p-value
(Intercept)	-1.4984354	0.4163013	192	-3.599401	0.0004
Years	0.0108641	0.0108498	192	1.001324	0.3179
Ndep_levlow	0.6800536	0.5887499	8	1.155081	0.2814
Years:Ndep_levlow	0.0188167	0.0152062	192	1.237441	0.2174

Correlation:

	(Intr)	Years	Ndp_lv
Years	-0.006		
Ndep_levlow	-0.707	0.004	
Years:Ndep_levlow	0.004	-0.714	-0.001

Standardized Within-Group Residuals:

Min	Q1	Med	Q3	Max
-3.3920483	-0.4883518	-0.0185723	0.4928521	3.5496385

Number of Observations: 204
 Number of Groups: 10

##Model IV – climate and Ndep## Results are reported in the Table 4

Linear mixed-effects model fit by maximum likelihood

Data: ICP
 AIC BIC logLik
 527.1349 550.3617 -256.5674

Random effects:
 Formula: ~1 | Site_Sp
 (Intercept) Residual
 StdDev: 0.464069 0.8221704

Correlation Structure: AR(1)
 Formula: ~1 | Site_Sp
 Parameter estimate(s):
 Phi

0.1391561
 Fixed effects: d15N ~ PFT + pca_s1 + sNdep

	Value	Std.Error	DF	t-value	p-value
(Intercept)	-1.2564004	0.2674005	194	-4.698572	0.0000
PFTConifer	-0.0401130	0.3700437	6	-0.108401	0.9172
pca_s1	0.5140102	0.1319351	6	3.895933	0.0080
sNdep	0.1367236	0.0708935	6	1.928576	0.1020

Correlation:

	(Intr)	PFTCnf	pca_s1
PFTConifer	-0.785		
pca_s1	0.184	-0.376	
cNdep	0.037	-0.189	0.844

Standardized Within-Group Residuals:

Min	Q1	Med	Q3	Max
-3.067836845	-0.506685097	-0.003448838	0.553031791	3.520814256

Number of Observations: 204
 Number of Groups: 10

R2m R2c
 0.4275086 0.5658329

```
#####
#####Running LME model without Sitka spruce stands#####
#####
```

##Model I: Saturated model with climate and atmospheric factors included as fixed term.##

Linear mixed-effects model fit by maximum likelihood

Data: ICP1

	AIC	BIC	logLik
	288.3882	315.393	-134.1941

Random effects:

Formula: ~1 | Site_Sp
(Intercept) Residual

StdDev: 0.5139886 0.7676987

Correlation Structure: AR(1)

Formula: ~1 | Site_Sp

Parameter estimate(s):

Phi

0.06829173

Fixed effects: d15Nw ~ PFT + pca_s1 + pca_a1 + pca_a3 + sNdep + aNdep

	Value	Std.Error	DF	t-value	p-value
(Intercept)	-1.2203108	0.3058928	99	-3.989342	0.0001
PFTConifer	0.0036607	0.4419866	4	0.008282	0.9938
pca_s1	0.5002865	0.1515884	4	3.300296	0.0299
pca_a1	0.0037404	0.0378407	99	0.098846	0.9215
pca_a3	-0.0184461	0.0578613	99	-0.318800	0.7506
sNdep	0.1641761	0.0833430	4	1.969885	0.1202
aNdep	-0.0032547	0.0373517	99	-0.087136	0.9307

Correlation:

	(Intr)	PFTCnf	pca_s1	pca_a1	pca_a3	cNdep
PFTConifer	-0.736					
pca_s1	0.193	-0.297				
pca_a1	0.044	-0.038	-0.033			
pca_a3	0.029	0.008	0.020	0.023		
sNdep	-0.008	-0.093	0.789	-0.042	0.024	
aNdep	0.000	0.008	-0.017	0.180	-0.242	-0.019

Standardized Within-Group Residuals:

	Min	Q1	Med	Q3	Max
	-3.55104018	-0.46649322	0.07335732	0.58231563	2.24564413

Number of Observations: 110

Number of Groups: 8

	R2m	R2c
	0.3832268	0.5741267

##Model II: Including only significant predictor from model I and sNdep#

Linear mixed-effects model fit by maximum likelihood

Data: ICP1

	AIC	BIC	logLik
	399.4583	421.1146	-192.7292

Random effects:

Formula: ~1 | Site_Sp
(Intercept) Residual

StdDev: 0.4886214 0.7556959

Correlation Structure: AR(1)

Formula: ~1 | Site_Sp

Parameter estimate(s):

Phi

0.1191216

Fixed effects: d15N ~ PFT + pca_s1 + sNdep

	Value	Std.Error	DF	t-value	p-value
(Intercept)	-1.3099814	0.2798656	155	-4.680751	0.0000

```

PFTConifer -0.0482108 0.4052451 4 -0.118967 0.9110
pca_s1 0.4885342 0.1387827 4 3.520138 0.0244
sNdep 0.1538956 0.0765167 4 2.011269 0.1146
Correlation:
(Intr) PFTCnf pca_s1
PFTConifer -0.737
pca_s1 0.199 -0.303
sNdep -0.003 -0.098 0.789

```

```

Standardized Within-Group Residuals:
      Min      Q1      Med      Q3      Max
-3.32703764 -0.52560566 -0.03014143 0.59893781 2.41937776

```

```

Number of Observations: 163
Number of Groups: 8

```

```

      R2m      R2c
0.3887468 0.5689547

```

###Model III: Including Ndep levels (low and high) in the model and the significant predictor from model I##

Linear mixed-effects model fit by maximum likelihood

```

Data: ICP1
      AIC      BIC    logLik
401.2295 422.8858 -193.6148

```

Random effects:

```

Formula: ~1 | Site_Sp
      (Intercept) Residual
StdDev: 0.5532536 0.7557414

```

Correlation Structure: AR(1)

```

Formula: ~1 | Site_Sp
Parameter estimate(s):
Phi
0.1192319

```

Fixed effects: d15N ~ PFT + pca_s1 + Ndep_lev

```

      Value Std.Error DF   t-value p-value
(Intercept) -0.8184941 0.4890670 155 -1.6735826 0.0962
PFTConifer -0.1666699 0.4752061   4 -0.3507318 0.7435
pca_s1 0.3812515 0.1286238   4 2.9640818 0.0414
Ndep_levlow -0.7370335 0.5661623   4 -1.3018060 0.2629

```

```

Correlation:
(Intr) PFTCnf pca_s1
PFTConifer -0.695
pca_s1 0.673 -0.475
Ndep_levlow -0.769 0.320 -0.674

```

```

Standardized Within-Group Residuals:
      Min      Q1      Med      Q3      Max
-3.2983484 -0.5169073 -0.0246089 0.6050976 2.3439261

```

```

Number of Observations: 163
Number of Groups: 8

```

```

      R2m      R2c
0.336869 0.5682523

```

#####Model IV: Including only Years x Ndep level as fixed factor##

Linear mixed-effects model fit by maximum likelihood

```

Data: ICP1
      AIC      BIC    logLik
402.4857 424.142 -194.2429

```

Random effects:

```

Formula: ~1 | Site_Sp
      (Intercept) Residual
StdDev: 0.8746482 0.7378314

```

Correlation Structure: AR(1)

Formula: ~1 | Site_Sp

Parameter estimate(s):

Phi

0.07757203

Fixed effects: d15N ~ Years * Ndep_lev

	Value	Std.Error	DF	t-value	p-value
(Intercept)	-1.5435600	0.4516239	153	-3.417800	0.0008
cYears	0.0190137	0.0108614	153	1.750569	0.0820
Ndep_levlow	0.4017296	0.6387864	6	0.628895	0.5526
cYears:Ndep_levlow	-0.0012910	0.0154290	153	-0.083676	0.9334

Correlation:

	(Intr)	cYears	Ndp_lv
cYears	-0.001		
Ndep_levlow	-0.707	0.001	
Years:Ndep_levlow	0.001	-0.704	0.002

Standardized Within-Group Residuals:

Min	Q1	Med	Q3	Max
-3.56483329	-0.45974831	-0.03668289	0.58640721	2.51359441

Number of Observations: 163

Number of Groups: 8

R2m	R2c
0.04516969	0.6030218

#####End#####