New Phytologist Supporting Information

Phylogenetic and biogeographic controls of plant nighttime stomatal conductance

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Table S1 A summary of species information used in this study.

Species	Life_Form	Num_Obs	Köppen_Cli	Cli_Biome	Nat_Con
Euphorbia amygdaloides	Forb	8705	Cfb	Bo	Europe
Rudbeckia fulgida	Forb	102	Cfa	TeW	North America
Centaurea montana	Forb	6116	Dfb	TeW	Europe
Dicentra spectabilis	Forb	5	BSk	TeW	Asia
Iris pallida	Forb	76	Dfb	TeW	Europe
Alchemilla mollis	Forb	2464	Cfb	TeD	Europe
Brunnera macrophylla	Forb	622	Dfb	TeD	Europe
Scirpus microcarpus	Forb	1171	Dfb	Bo	North America
Monarda fistulosa	Forb	1282	Dfa	TeW	North America
Maianthemum stellatum	Forb	1743	Dfb	TeW	North America
Balsamorhiza sagittata	Forb	650	BSk	Bo	North America
Paeonia officinalis	Forb	1128	Dfb	Bo	Europe
Phlox paniculata	Forb	214	Dfa	TeD	North America
Sedum spathulifolium	Forb	393	Csb	TeD	North America
Crambe maritima	Forb	514	Cfb	TeW	Europe
Levisticum officinale	Forb	1151	Dfb	TeW	Europe
Arum italicum	Forb	5329	Cfb	Bo	Europe
Mertensia brevistyla	Forb	49	Dfb	Bo	North America
Wyethia amplexicaulis	Forb	141	Dfb	Bo	North America
Penstemon cyananthus	Forb	130	Dfb	TeD	North America
Geranium macrorrhizum	Forb	807	Dfb	TeW	Europe
Artemisia vulgaris	Forb	7247	Dfb	TeW	Europe

Geranium pratense	Forb	9163	Cfb	TeW	Europe
Panicum virgatum	Grass	1433	Dfa	TeW	North America
Sesleria autumnalis	Grass	49	Csa	TeW	Europe
Calamagrostis acutiflora	Grass	41	Dfb	TeD	Europe
Phalaris arundinacea	Grass	1382	Dfb	Bo	North America
Saccharum ravennae	Grass	317	BSk	TeW	Europe
Stipa nelsonii	Grass	583	Dfb	TeW	North America
Poa pratensis	Grass	9786	Dfc	Bo	Europe
Cornus sericea	Shrub	2495	Dfb	Bo	North America
Cornus alba	Shrub	21	Dwb	Bo	Asia
Magnolia stellata	Shrub	6	Cfa	Bo	Asia
Hydrangea quercifolia	Shrub	149	Cfa	Bo	North America
Mahonia repens	Shrub	29	Csa	TeW	North America
Viburnum lentago	Shrub	479	Dfb	TeW	North America
Aesculus parviflora	Shrub	57	Cfa	TeW	North America
Syringa vulgaris	Shrub	24401	Cfb	TeW	Europe
Viburnum carlesii	Shrub	4	Cfa	TeW	Asia
Cornus sanguinea	Shrub	20982	Cfb	TeW	Europe
Hibiscus syriacus	Shrub	198	Cfa	TeW	Asia
Prunus virginiana	Shrub	1368	Dfb	Bo	North America
Rhus typhina	Shrub	1104	Dfb	Bo	North America
Symphoricarpos oreophilus	Shrub	376	BSk	TeW	North America
Ribes aureum	Shrub	1123	BSk	TeW	North America
Rhus trilobata	Shrub	851	BSk	TeD	North America
Tilia cordata	Tree	20017	Dfb	Bo	Europe
Acer palmatum	Tree	491	Cfa	Bo	Asia
Pyrus pyrifolia	Tree	247	Cfa	Bo	Asia
Pyrus communis	Tree	12625	Cfb	Bo	Europe
Acer buergerianum	Tree	180	Cfa	TeW	Asia
Picea pungens	Tree	110	Dfb	TeW	North America
Pinus leucodermis	Tree	4	Csa	TeW	Europe

Cotinus coggygria	Tree	738	Cfb	TeW	Europe
Abies koreana	Tree	5	Cfa	TeW	Asia
Carpinus betulus	Tree	20657	Cfb	Bo	Europe
Acer grandidentatum	Tree	171	Dfb	TeW	North America
Quercus gambelii	Tree	459	BSk	TeW	North America
Pinus aristata	Tree	72	Dfb	Bo	North America
Pinus edulis	Tree	390	BSk	Bo	North America
Heptacodium miconioides	Tree	3	Cfa	TeD	Asia
Cedrus atlantica	Tree	673	Cfb	TeW	Europe
Quercus acutissima	Tree	232	Cfa	Bo	Asia
Quercus muehlenbergii	Tree	560	Dfa	TeD	North America
Populus angustifolia	Tree	239	Dfb	TeD	North America
Pinus heldreichii	Tree	36	Csa	TeD	Europe
Pinus ponderosa	Tree	1110	BSk	TeW	North America
Quercus turbinella	Tree	254	BSk	TeW	North America
Quercus texana	Tree	36	Cfa	TeW	North America
Populus tremuloides	Tree	1842	Dfb	Bo	North America
Acer negundo	Tree	2641	Dfb	TeW	North America
Acer griseum	Tree	14	Cwa	TeD	Asia
Viburnum plicatum	Tree	435	Cfa	TeW	Asia

Note: [1]Num_Obs refers to number of georeferenced records in GBIF following the filter criteria, Köppen_Cli refers to the Köppen climate classification based on the maximum of Num_Obs, Cli_Biome refers to climate zone classified using the Köppen climate classification; Bo: Boreal; TeW: Temperate Wet; TeD: Temperate Dry; Nat_Con refers to species native continent

[2]Leaves for grasses were rectangles; Leaves for *Picea pungens* and *Cedrus atlantica* are cylinders; Leaves for *Pinus leucodermis*, *Pinus aristata*, and *Pinus edulis* are semicylinders; Leaves for *Abies Koreana* are rectangles.

Figure Legends

Figure S1 Relationship between species' maximum plant night time stomatal conductance (g_{sn}) and median of annual precipitation (MAP). Regression lines represent univariate relationships rather than the output of the full model and are for visualization purposes only. (b) Mean decrease in accuracy (%IncMSE, mean and standard deviation estimated from 1000 simulations of random forests in evaluating the importance of native climate, represented by median, on g_{sn}. Native climate variables are annual mean temperature (AMT), mean temperature of warmest quarter (MTW), annual precipitation (MAP), precipitation of driest quarter (PDQ) and vapor pressure deficit of driest quarter (VDQ). Soil organic matter (SOC) is represented as an approximation to native soil nutrient conditions.

Figure S2 Relationship between species' maximum plant night time stomatal conductance (g_{sn}) and its native climate and soil nutrients (soil nitrogen, SN) estimated from hierarchical Bayesian models. (a) Phylogenetic signal (Pagel's λ, mean and 95% CIs) for g_{sn} (n =64). (b, c) Standardized coefficient estimates (effective posterior means and 95% CIs) for the effects of native climate, represented by mean (b) and median (c), on g_{sn} (n = 64). Values reflect standardised data and can be interpreted as relative effect sizes. For native climate variables, see Figure S1.

Figure S3 Relationship between species' maximum plant night time stomatal conductance (g_{sn}) and its native climate and soil nutrients (soil organic matter, SOC) estimated from hierarchical Bayesian models after excluding species with less than 30 georeferenced records in GBIF. (a) Phylogenetic signal (Pagel's λ, mean and 95% CIs) for g_{sn} (n =64). (b, c) Standardized coefficient estimates (effective posterior means and 95% CIs) for the effects of native climate, represented by mean (b) and median (c), on g_{sn} (n = 64). Values reflect standardised data and can be interpreted as relative effect sizes. For native climate and soil nutrient variables, see Figure S1.

Figure S4 Means and 95% CIs of g_{sn} among different life forms (a) and different climate zones (b) without accounting for possible effects of shared evolutionary history (phylogenetics). Life forms are trees, shrubs, grasses and grasses. boreal (Bo), temperate dry (TeD), and temperate wet (TeW).

Figure S5 Relationship between species' maximum plant night time stomatal conductance (g_{sn}) and its native climate and soil nutrients (soil organic matter, SOC) estimated from hierarchical

Bayesian models which also account for plant life forms as a random effect. (a) Phylogenetic signal (Pagel's λ, mean and 95% CIs) for g_{sn} (n = 73). (b, c) Standardized coefficient estimates (effective posterior means and 95% CIs) for the effects of native climate, represented by mean (b) and median (c), on g_{sn} (n = 73). Values reflect standardised data and can be interpreted as relative effect sizes. For native climate and soil nutrient variables, see Figure S1.

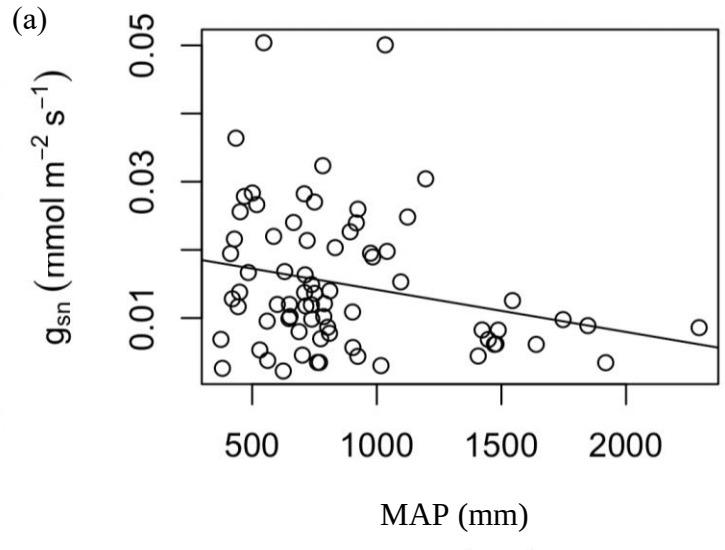
Figure S6 Relationship between species' maximum plant night time stomatal conductance (g_{sn}) and (a) local volumetric soil water content, (b) plant day time stomatal conductance (g_{sd}), (c) daytime photosynthetic rate (Ad), (d) plant night time respiration estimated by univariate regression analysis. Blue line with bands representing 95% confidence interval.

Figure S7 Relationship between species' maximum plant night time stomatal conductance (g_{sn}) and plant traits including maximum carboxylation capacity (V_{cmax}, a), stomata density (b), and specific leaf area (SLA, c) estimated by univariate regression analysis. Blue line with bands representing 95% confidence interval.

Figure S8 Relationship between species' maximum plant night time stomatal conductance (g_{sn}) and its native climate and soil nutrients (soil organic matter, SOC) estimated from hierarchical Bayesian models which also account for plant life forms as a random effect and maximum carboxylation capacity (V_{cmax}) as a fixed effect. (a) Phylogenetic signal (Pagel's λ, mean and 95% CIs) for g_{sn} (n = 73). (b, c) Standardized coefficient estimates (effective posterior means and 95% CIs) for the effects of native climate, represented by mean (b) and median (c), on g_{sn} (n = 73). Values reflect standardised data and can be interpreted as relative effect sizes. For native climate and soil nutrient variables, see Figure S1.

Figure S9. Annual precipitation (MAP, mean and 95% CIs) in boreal (Bo), temperate dry (TeD), and temperate wet (TeW) biomes.

(a)


g_{sn} (mmol m^{-2} s^{-1})
0.01
0.03
0.05
500
1000
1500
2000
MAP (mm)

(b)

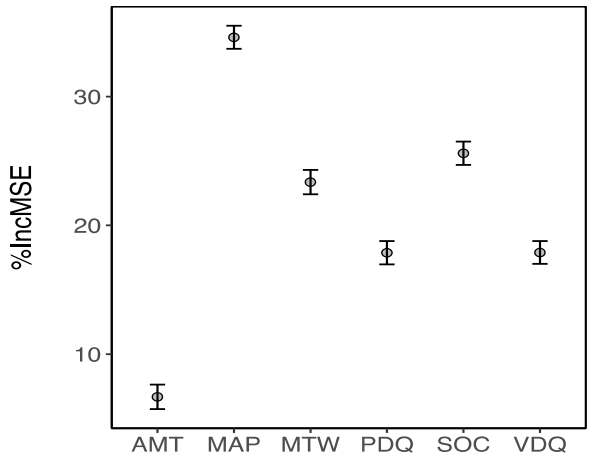

%IncMSE
10
20
30
AMT
MAP
MTW
PDQ
SOC
VDQ

Figure S1

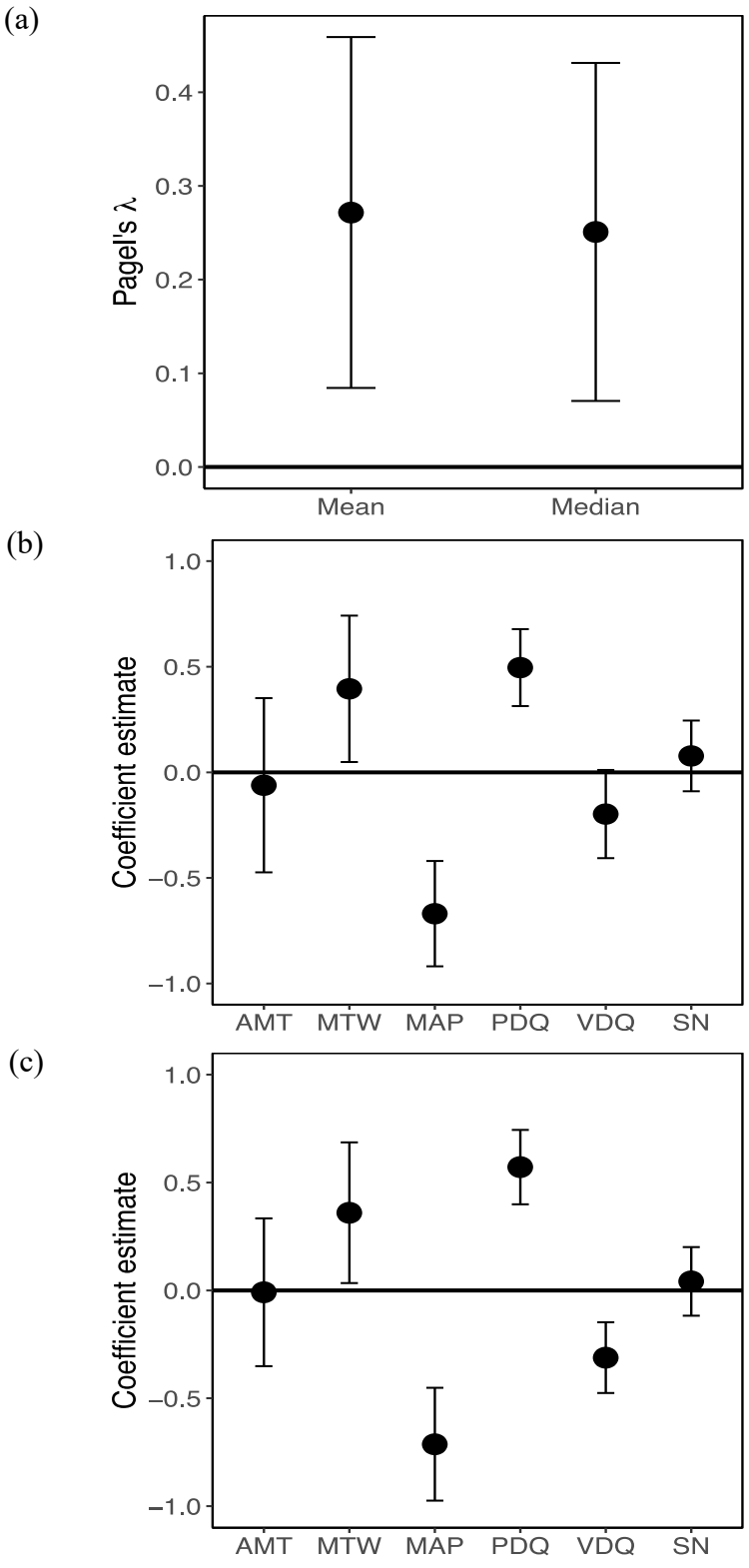
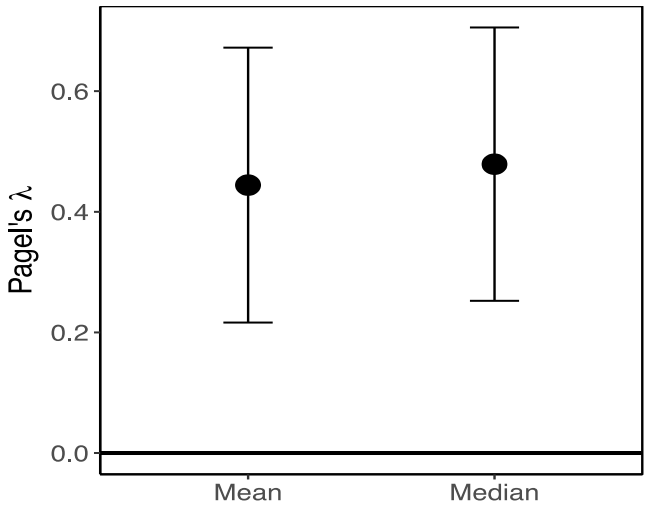
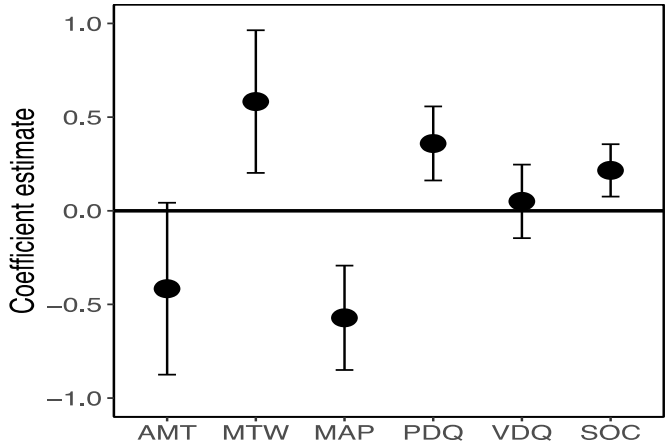

(a)
Pagel's λ
0.4
0.3
0.2
0.1
0.0
Mean
Median
(b)
Coefficient estimate
1.0
0.5
0.0
−0.5
−1.0
AMT
MTW
MAP
PDQ
VDQ
SN
(c)
Coefficient estimate
1.0
0.5
0.0
−0.5
−1.0
AMT
MTW
MAP
PDQ
VDQ
SN

Figure S2

(a)



(b)



(c)

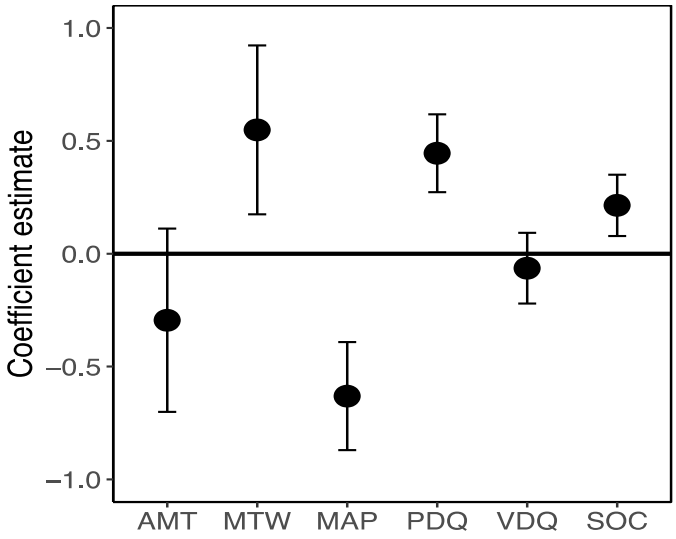


Figure S3

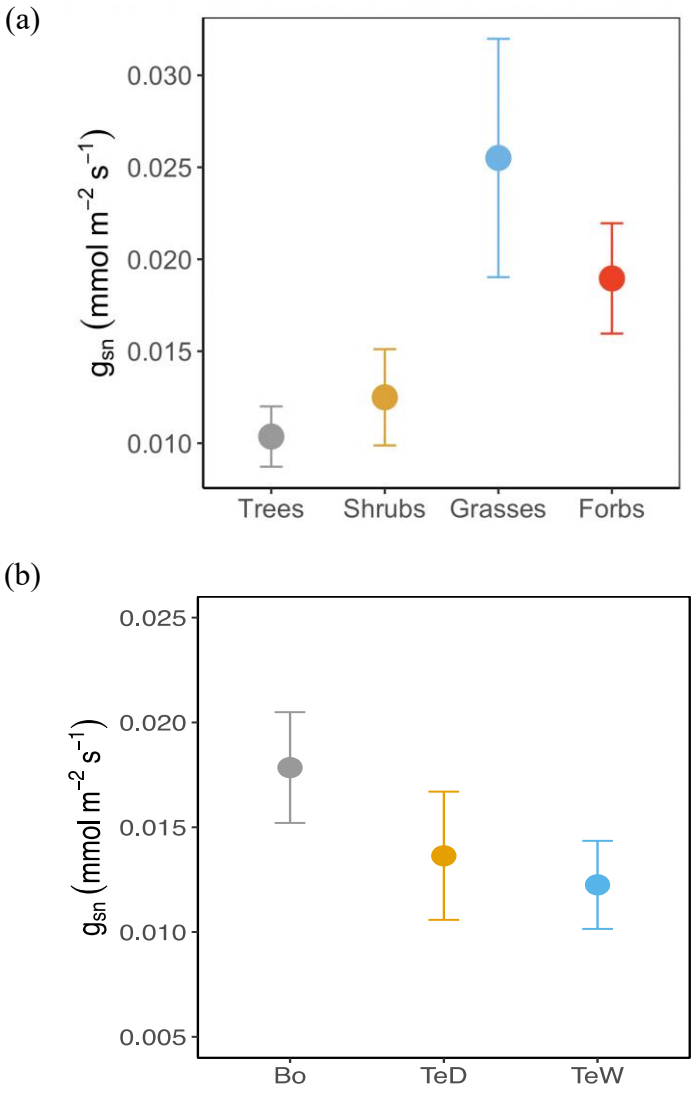
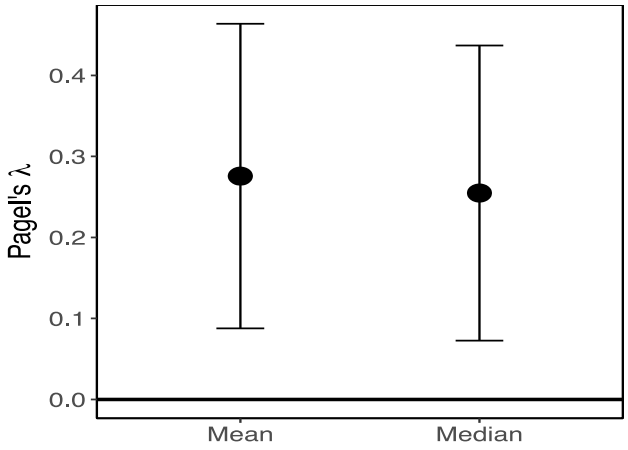
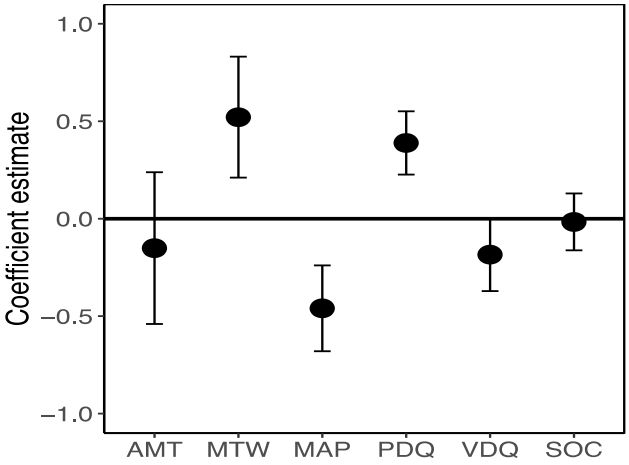

(a)
0.030
0.025
0.020
0.015
0.010
g_{sn} (mmol m^{-2} s^{-1})
Trees
Shrubs
Grasses
Forbs
(b)
0.025
0.020
0.015
0.010
0.005
g_{sn} (mmol m^{-2} s^{-1})
Bo
TeD
TeW

Figure S4

(a)



(b)



(c)

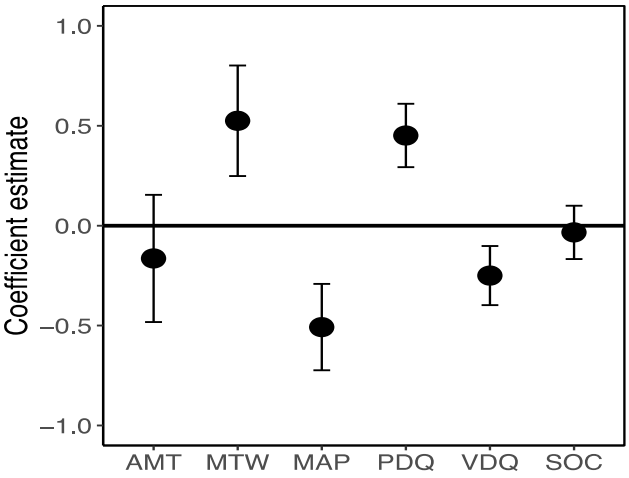


Figure S5

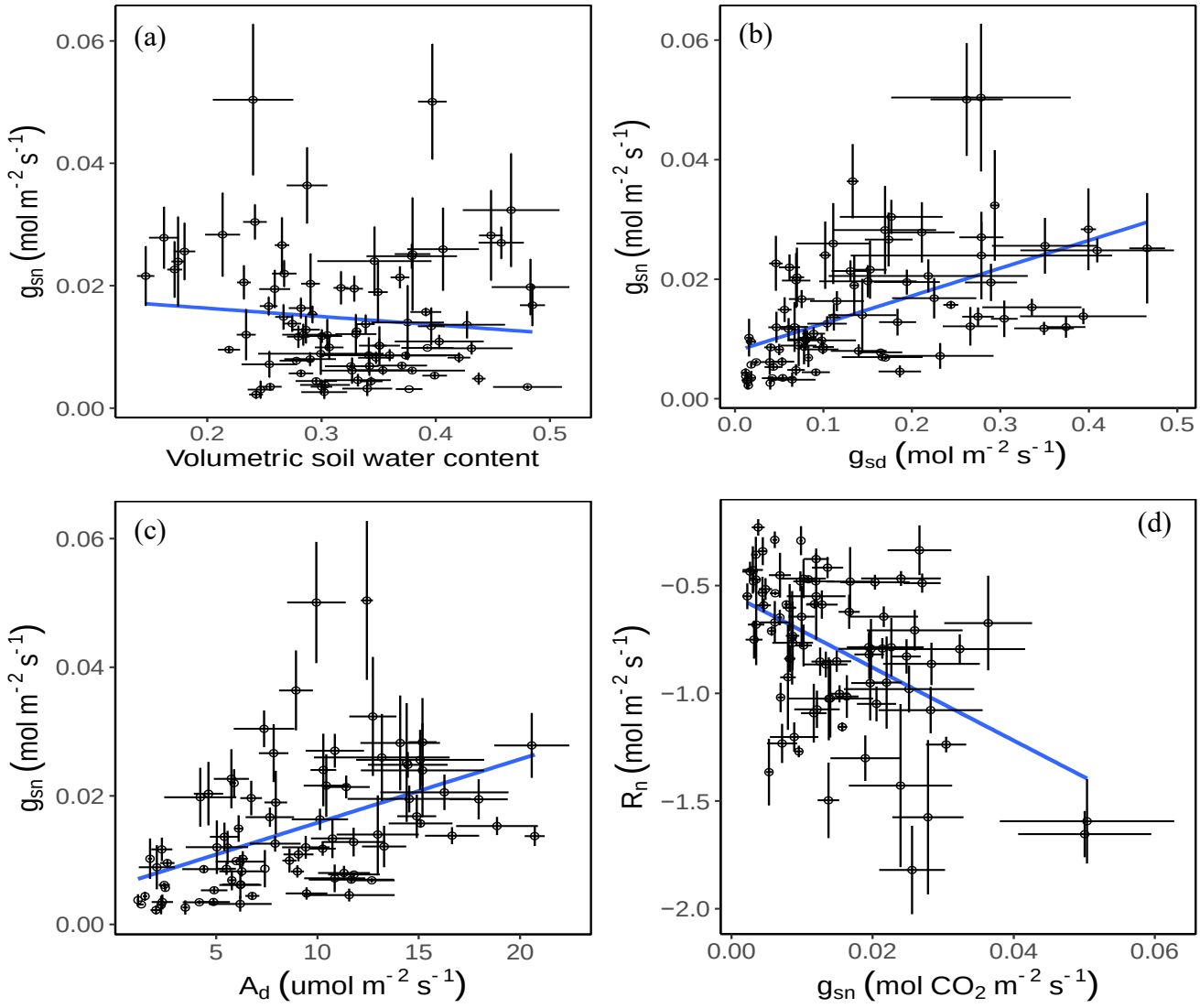

(a)
(b)
(c)
(d)
Volumetric soil water content
g_{sd} (mol m^{-2} s^{-1})
A_d (umol m^{-2} s^{-1})
g_{sn} (mol CO_2 m^{-2} s^{-1})
g_{sn} (mol m^{-2} s^{-1})
R_n (mol m^{-2} s^{-1})

Figure S6

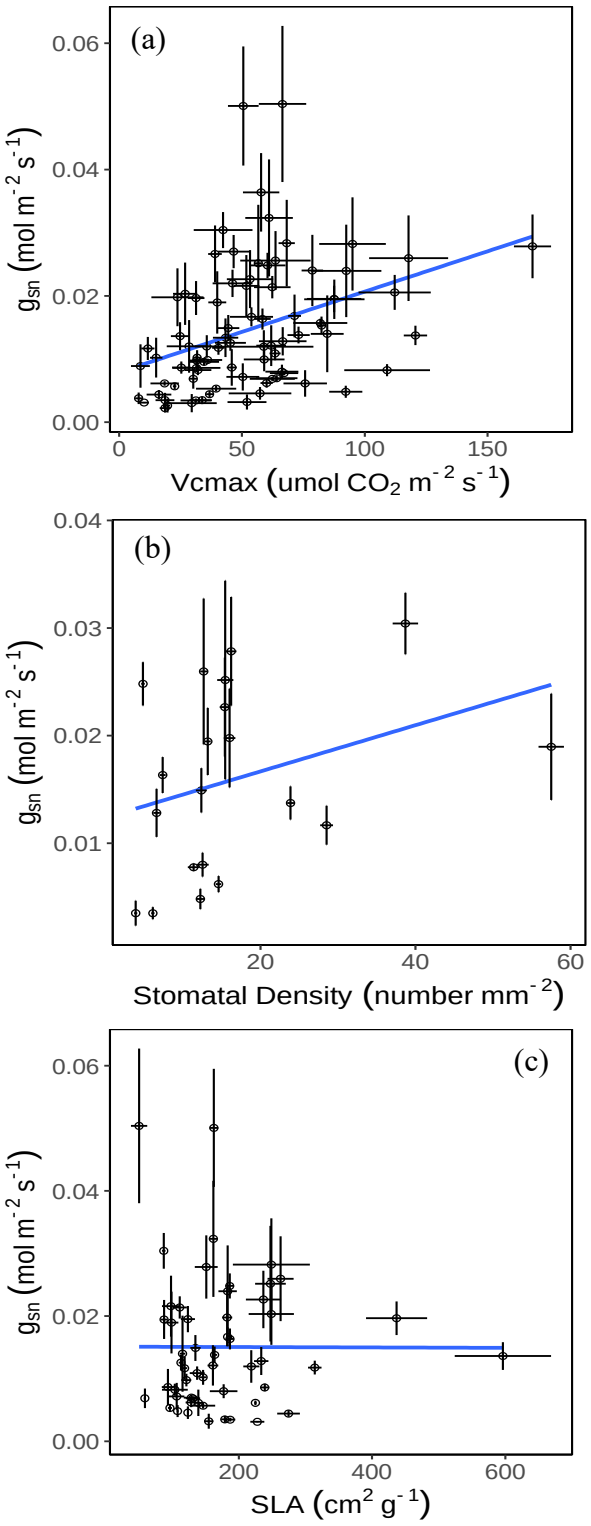
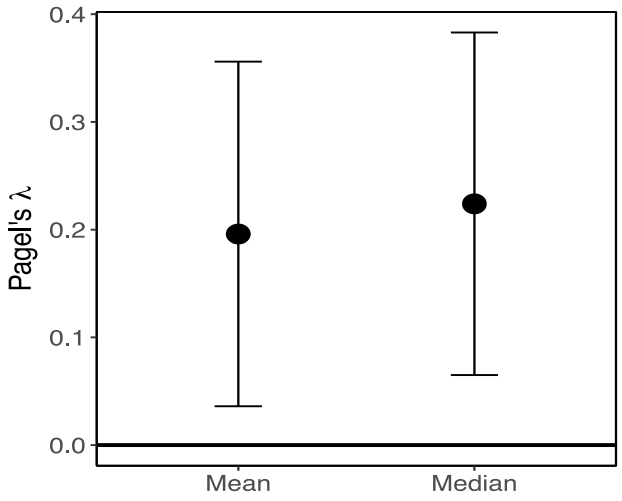
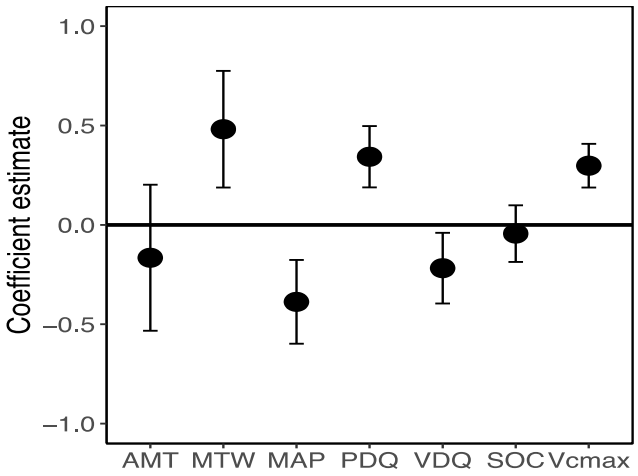

(a)
0.06
0.04
0.02
0.00
g_{sn} (mol m^{-2} s^{-1})
0
50
100
150
Vcmax (umol CO_2 m^{-2} s^{-1})
(b)
0.04
0.03
0.02
0.01
g_{sn} (mol m^{-2} s^{-1})
20
40
60
Stomatal Density (number mm^{-2})
(c)
0.06
0.04
0.02
0.00
g_{sn} (mol m^{-2} s^{-1})
200
400
600
SLA (cm^2 g^{-1})

Figure S7

(a)



(b)



(c)

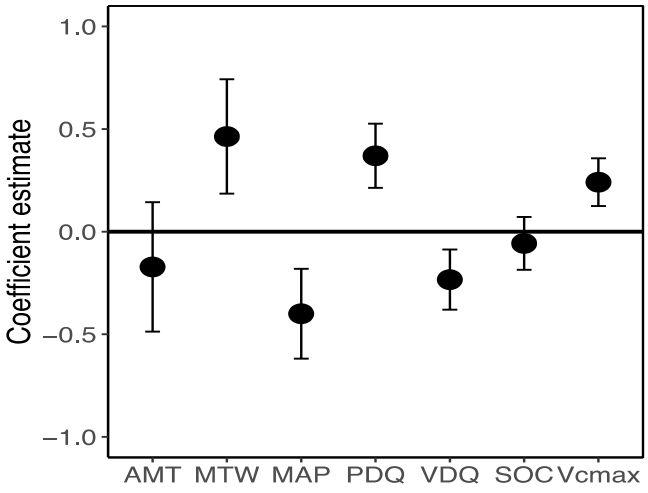


Figure S8

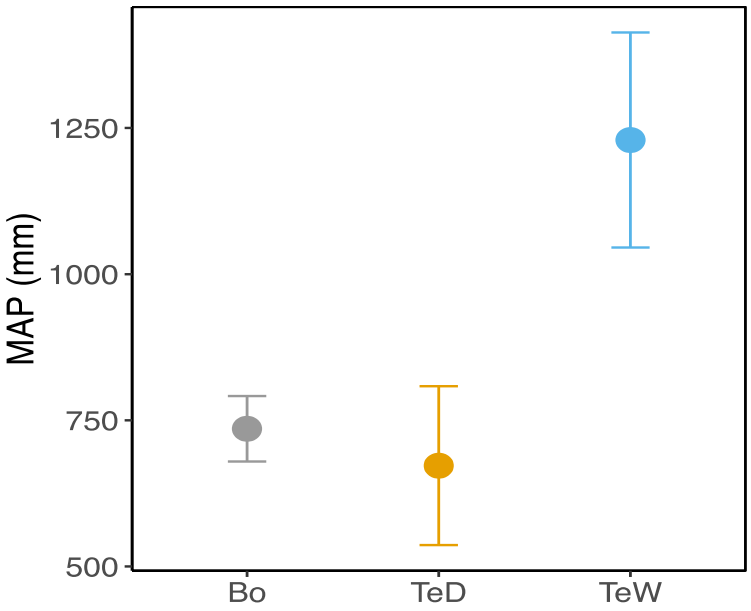


Figure S9