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Supplement of

Crowd-sourced trait data can be used to delimit global biomes

Simon Scheiter et al.

Correspondence to: Simon Scheiter (simon.scheiter@senckenberg.de)

Table S1: Traits included in the clustering. 'TRY ID' and 'TRY trait name' refer to the IDs and names used in the TRY trait database (Kattge et al. 2020).

TRY ID	Abbreviation	TRY trait name
X4	WoodDensity	Stem specific density (SSD) or wood density (stem dry mass per stem fresh volume)
X6	RootDepth	Root rooting depth
X11	SLA	Leaf area per leaf dry mass (specific leaf area, SLA or 1/LMA)
X13	LeafC	Leaf carbon (C) content per leaf dry mass
X14	LeafN	Leaf nitrogen (N) content per leaf dry mass
X15	LeafP	Leaf phosphorus (P) content per leaf dry mass
X18	Height	Plant height
X21	StemDiameter	Stem diameter
X26	SeedMass	Seed dry mass
X27	SeedLength	Seed length
X46	LeafThickness	Leaf thickness
X47	LeafDMC	Leaf dry mass per leaf fresh mass (leaf dry matter content, LDMC)
X50	LeafNArea	Leaf nitrogen (N) content per leaf area
X55	LeafMassSingle	Leaf dry mass (single leaf)
X78	LeafNIsotope	Leaf nitrogen (N) isotope signature (delta 15N)
X95	SeedGerm	Seed germination rate (germination efficiency)
X138	SeedNumber	Seed number per reproduction unit
X144	LeafLenght	Leaf length
X145	LeafWidth	Leaf width
X146	LeafCN	Leaf carbon/nitrogen (C/N) ratio
X163	LeafMass	Leaf fresh mass
X169	ConduitDensity	Stem conduit density (vessels and tracheids)
X223	ChromNumber	Species genotype: chromosome number
X224	ChromCDNA	Species genotype: chromosome cDNA content
X237	Dispersal	Dispersal unit length
X281	ConduitDiameter	Stem conduit diameter (vessels, tracheids)
X282	VesselLength	Wood vessel element length; stem conduit (vessel and tracheids) element length
X289	FiberLength	Wood fiber lengths
X1080	SRL	Root length per root dry mass (specific root length, SRL)
X3112	LeafArea1	Leaf area (in case of compound leaves: leaf, undefined if petiole in- or excluded)
X3113	LeafArea2	Leaf area (in case of compound leaves: leaflet, undefined if petiole is in- or excluded)
X3114	LeafArea3	Leaf area (in case of compound leaves: undefined if leaf or leaflet, undefined if petiole is in- or excluded)
X3120	LeafWater	Leaf water content per leaf dry mass (not saturated)

Table S2: Number of cluster analyses conducted for different numbers of traits and different F31 biome maps (Fischer et al. 2022) in the sensitivity analysis. For each cluster analysis, traits were sampled randomly from all 33 traits included in the analysis (see Table. S1).

Map	3	4	5	6	7	8	9	10	11	12	Sum
Map 1	122	109	87	81	57	66	39	35	33	24	653
Map 2	114	92	95	96	50	85	31	33	28	37	661
Map 3	105	150	94	92	51	64	34	35	41	27	693
Map 4	107	84	116	87	67	46	33	33	36	35	644
Map 5	109	122	86	90	55	41	31	30	39	32	635
Map 6	294	117	95	81	97	42	31	30	39	27	853
Map 7	257	89	84	134	63	41	42	30	35	26	801
Map 8	212	145	89	115	98	75	42	41	49	26	892
Map 9	122	87	88	78	74	50	38	37	28	24	626
Map 10	250	112	99	77	49	41	32	35	38	39	772
Map 11	125	118	76	85	59	39	42	38	38	29	649
Map 12	114	105	85	78	69	46	42	37	31	28	635
Map 13	113	86	81	79	65	77	37	36	46	38	658
Map 14	110	111	100	115	84	40	41	40	30	28	699
Map 15	334	94	98	129	50	36	32	49	29	37	888
Map 16	106	121	77	85	67	48	48	36	48	45	681
Map 17	124	88	83	87	69	41	40	37	32	27	628
Map 18	117	91	79	181	48	45	31	34	28	29	683
Map 19	118	123	81	79	55	42	55	31	33	31	648
Map 20	289	82	99	79	66	66	36	35	38	26	816
Map 21	114	89	92	118	47	42	44	42	32	30	650
Map 22	119	85	80	76	66	49	32	33	30	32	602
Map 23	260	84	88	94	46	41	31	31	39	36	750
Map 24	112	87	91	92	69	71	31	31	39	32	655
Map 25	109	118	85	104	63	40	31	43	56	33	682
Map 26	106	84	93	109	61	60	33	31	33	25	635
Map 27	260	89	94	176	47	43	42	31	26	26	834
Map 28	112	89	91	107	79	36	42	30	26	33	645
Map 29	293	107	91	88	51	47	49	69	32	25	852
Map 30	109	87	91	94	48	44	39	31	26	38	607
Map 31	120	85	95	161	46	99	35	37	34	28	740
Sum	4956	3130	2783	3147	1916	1603	1166	1121	1092	953	21867

Table S3: Word count of biome names in F31 maps. The attributes were group with respect to biome types, climate, growth form or phenology. Those groups were included separately in PCAs (sec. 2.5).

word	count	word	count
forest	179	broadleaf	40
desert	53	needleleaf	24
savanna	37	conifer	23
grassland	35	herbaceous	8
steppe	30	bush	9
tundra	29	tree	16
woodland	26	thorn	7
rainforest	24	dwarf	6
shrub	52		
semidesert	17	dry	67
cropland	17	cold	51
taiga	5	summer	50
		winter	30
temperate	84	warm	24
tropical	99	moist	23
subtropical	39	polar	24
boreal	28	hot	22
mediterranean	9	cool	14
		nemoral	13
evergreen	48	arid	12
deciduous	40	wet	13
summergreen	7	seasonal	7
mixed	22	xeric	7
open	24		
closed	22		

Table S4: Word count of biome names in F31 maps for biomes including the most frequent words from Table S3: 'tropical', 'temparate' and 'forest'. Those groups were included separately in PCAs (sec. 2.5).

word	count	word	count
tropical		*temparate*	
forest tropical	57	forest temperate	31
rainforest tropical	19	summer temperate	18
savanna tropical	13	dry temperate	19
desert tropical	15	warm temperate	17
dry tropical	11	cool temperate	10
grassland tropical	10	broadleaf temperate	8
broadleaf tropical	9	desert temperate	8
evergreen tropical	8	grassland temperate	8
seasonal tropical	7	evergreen temperate	7
moist tropical	6	hot temperate	6
deciduous tropical	4	season temperate	6
forest			
tropical forest	57		
evergreen forest	37		
broadleaf forest	33		
deciduous forest	31		
temperate forest	31		
rainforest forest	24		
subtropical forest	24		
mixed forest	18		
needleleaf forest	18		
boreal forest	16		
coniferous forest	15		

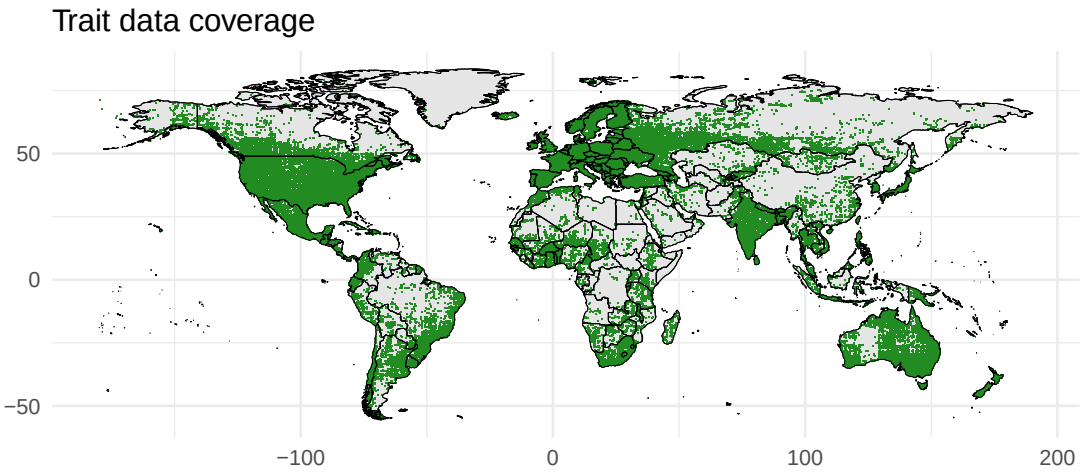

Figure S1: Coverage of trait data used in this study. Trait data were obtained by merging TRY trait data and GBIF species distribution data (see Methods for details). The spatial resolution is 0.5°.

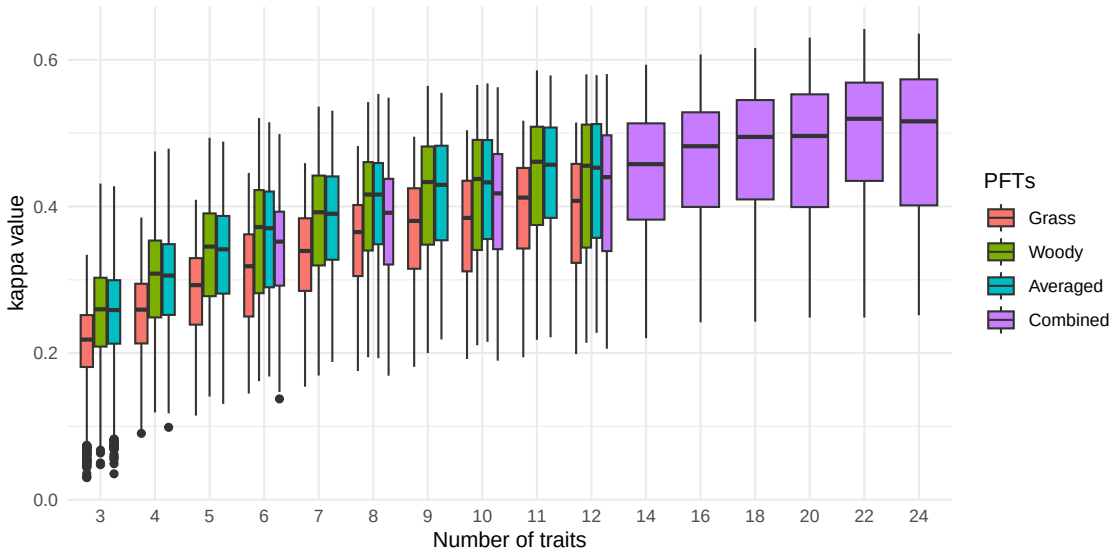

Figure S2: Relation between data-model agreement and the number of traits included in the cluster analysis. For each number of traits, the traits were randomly selected, and clustering was conducted for all F31 biome maps. At least 600 cluster analysis were conducted for each F31 map. Traits were sampled from those provided in Table S1 for different combinations of PFTs. Data-model agreement is represented by the κ statistics.

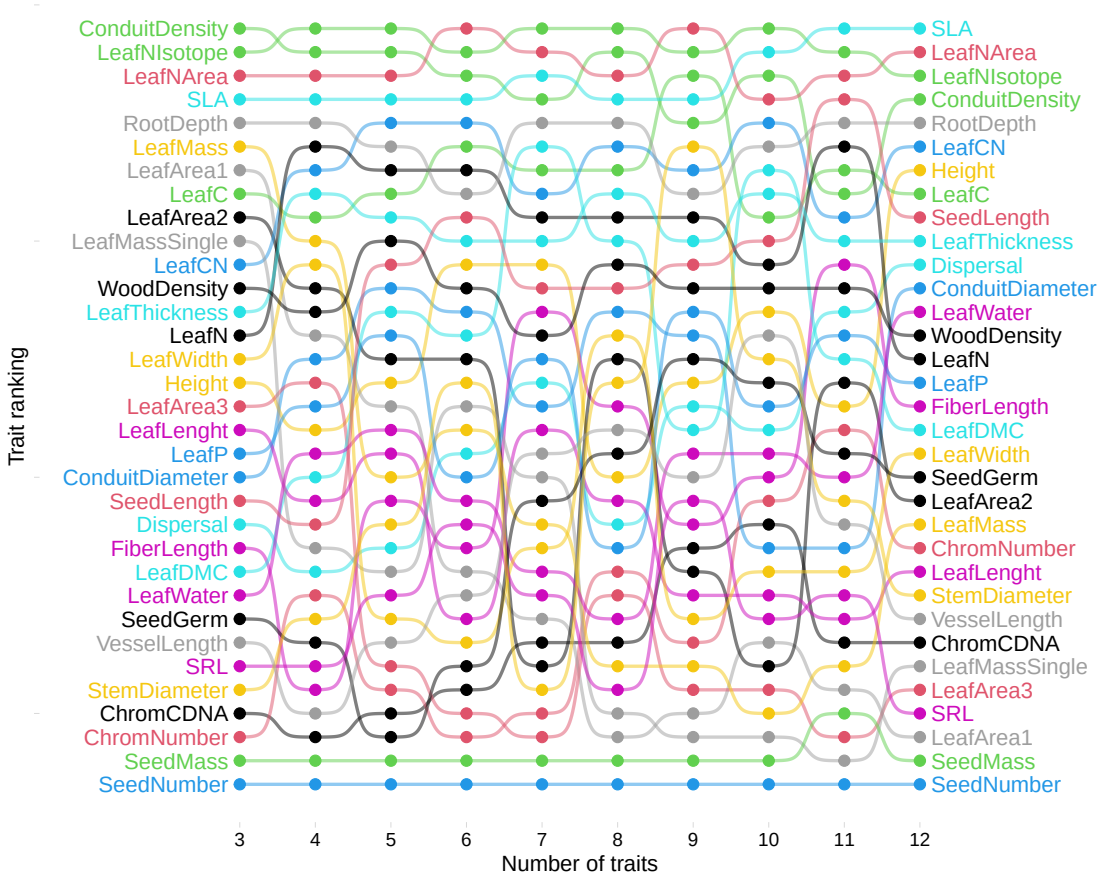

Figure S3: Ranking of traits in response to the number of traits in cluster analysis. For each number of traits, cluster analyses for all F31 biome maps were merged, and the 10% of all models with the highest κ value were selected. For these models, the number of models including each trait was counted, and counts were used to derive the ranking.

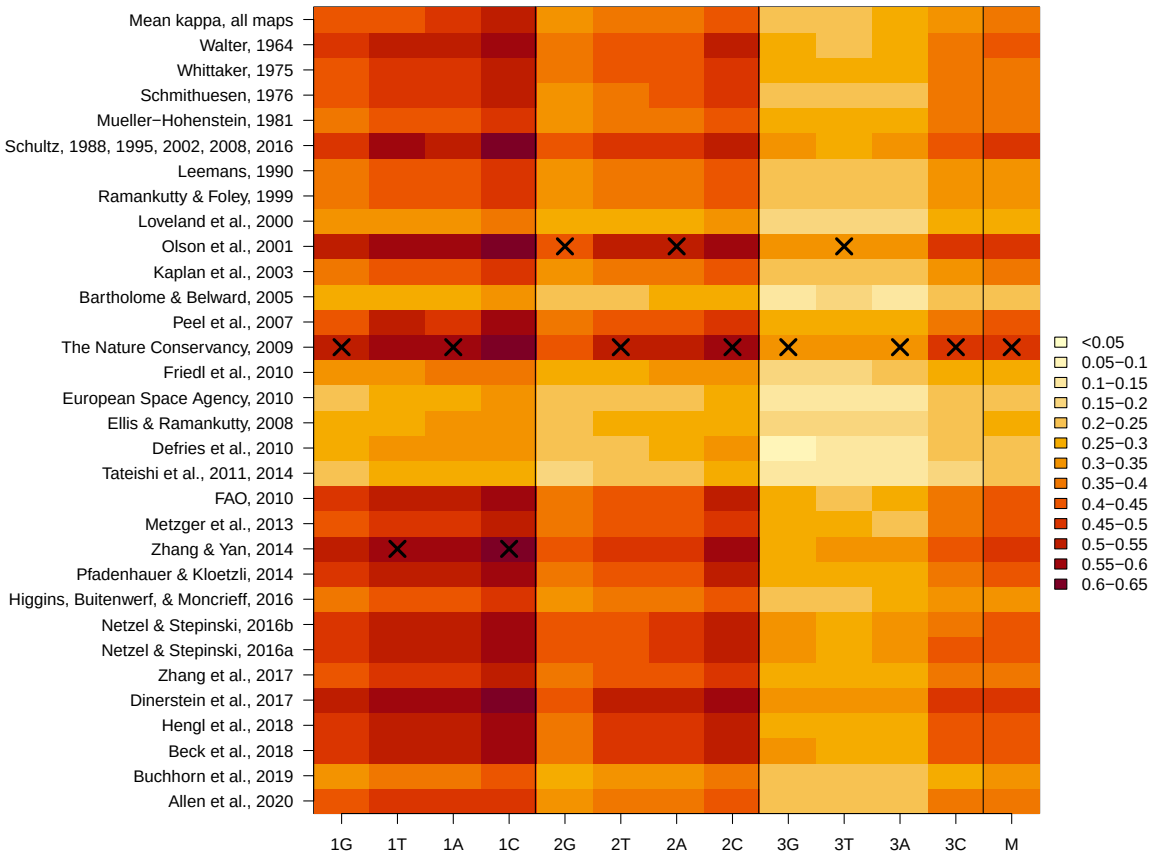

Figure S4: Data-model agreement for different biome maps and trait clusters used for the clustering. The figure shows κ values for all of the 31 biome maps provided by Fischer et al. (2022) for different trait clusters. Cluster 1 includes the 12 traits with highest rank in Fig. 3, cluster 2 includes conduit density, leaf thickness, leaf N, SLA and rooting depth, and cluster 3 includes wood density, height and SLA. 'G' represents clustering with traits of non-woody plants only, 'T' represents clustering with traits of woody plants only, 'A' represents clustering with all species (non-woody and woody plants), and 'C' represents clustering where both traits of non-woody and woody plants (from G and T) were combined. The 'X's' denote the biome map that maximized κ within each trait cluster (each column). The first row is the mean κ value for each trait cluster averaging all biome maps, the last column is the mean κ value for each biome map, averaging all trait clusters.

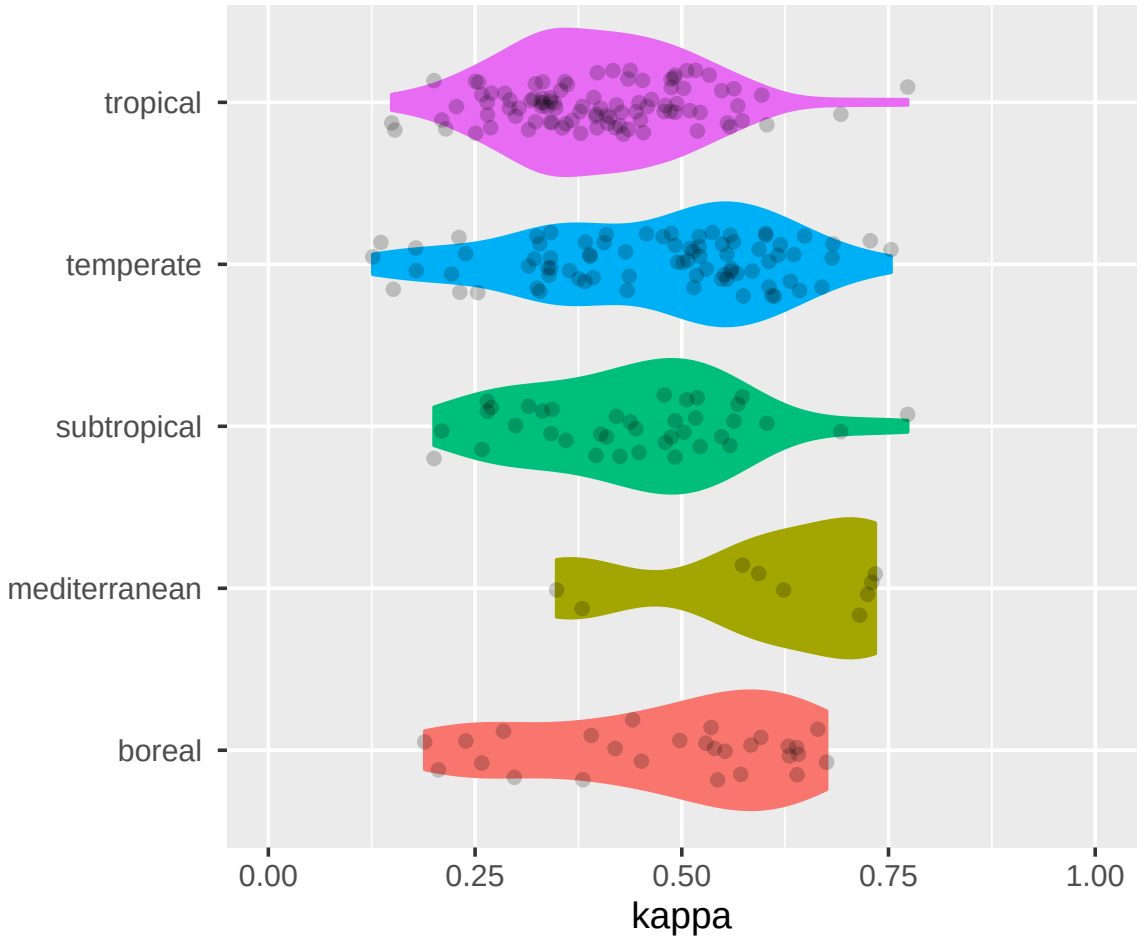

Figure S5: Model performance (κ values) in different biomes selected by climate zone. For this analysis, all F31 biome maps containing one of the words in the figure were selected, and κ values were calculated for those biomes.

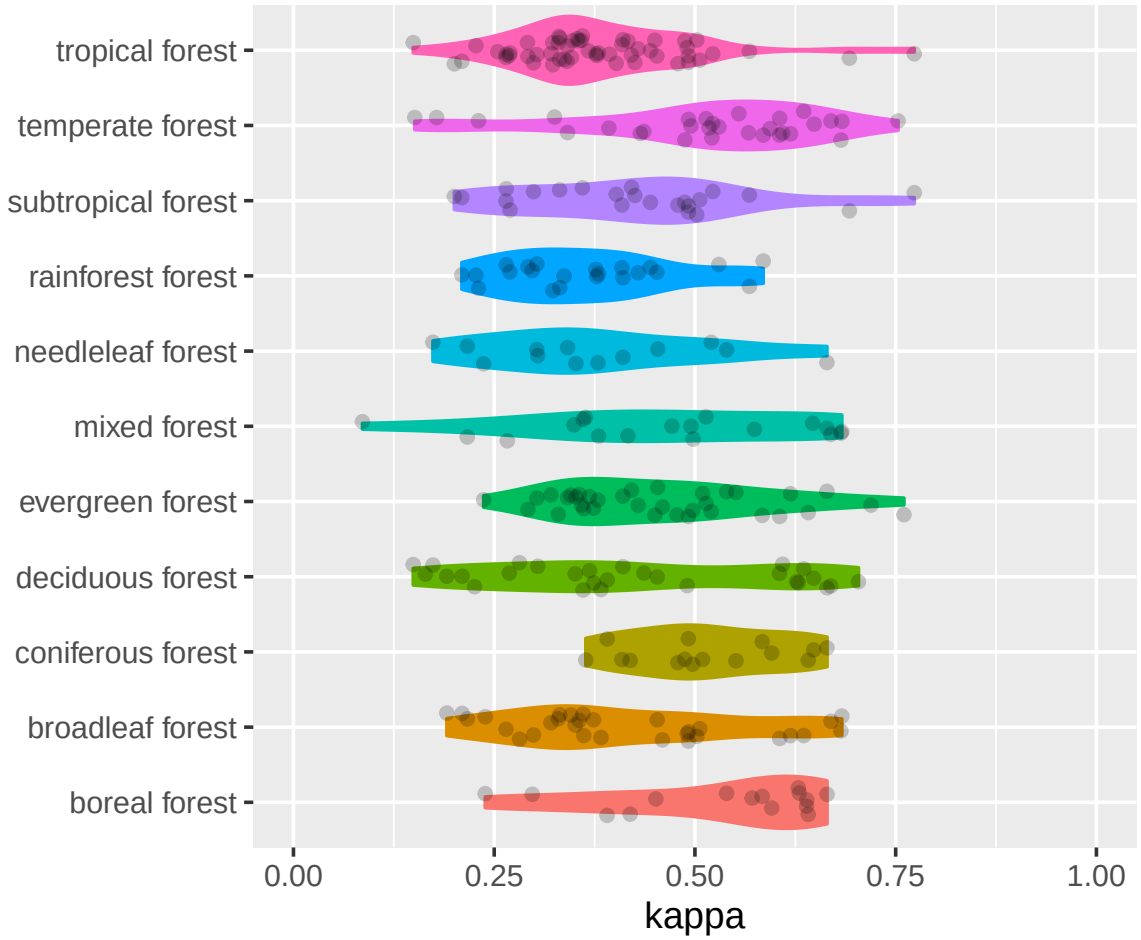

Figure S6: Model performance (κ values) in different forest types. For this analysis, all biomes that contain the attributes provided in the figure in their names were identified in the F31 biome maps. Then, the κ value was calculated for each biome (represented by the points in the figure).

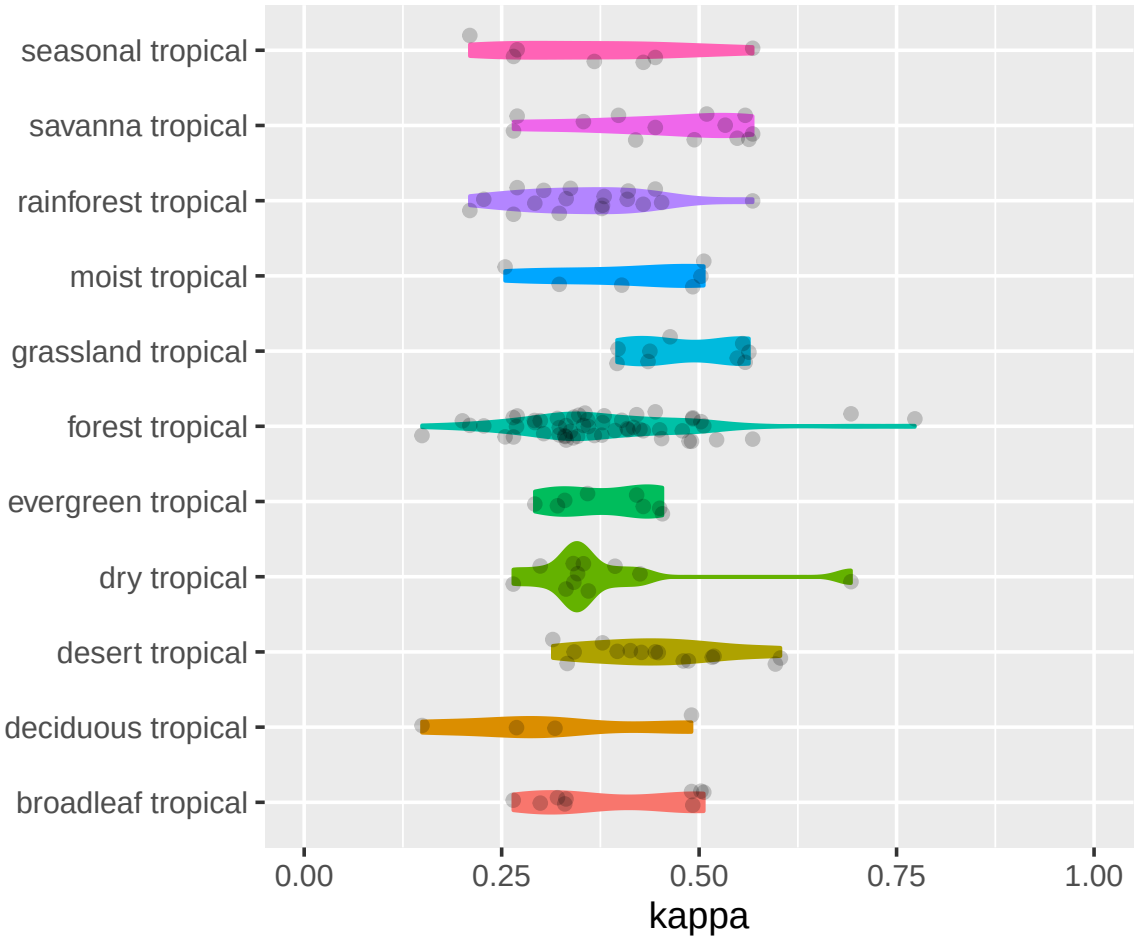

Figure S7: Model performance (κ values) in different biomes in tropical regions. For this analysis, all biomes that contain the attributes provided in the figure in their names were identified in the F31 biome maps. Then, the κ value was calculated for each biome (represented by the points in the figure).

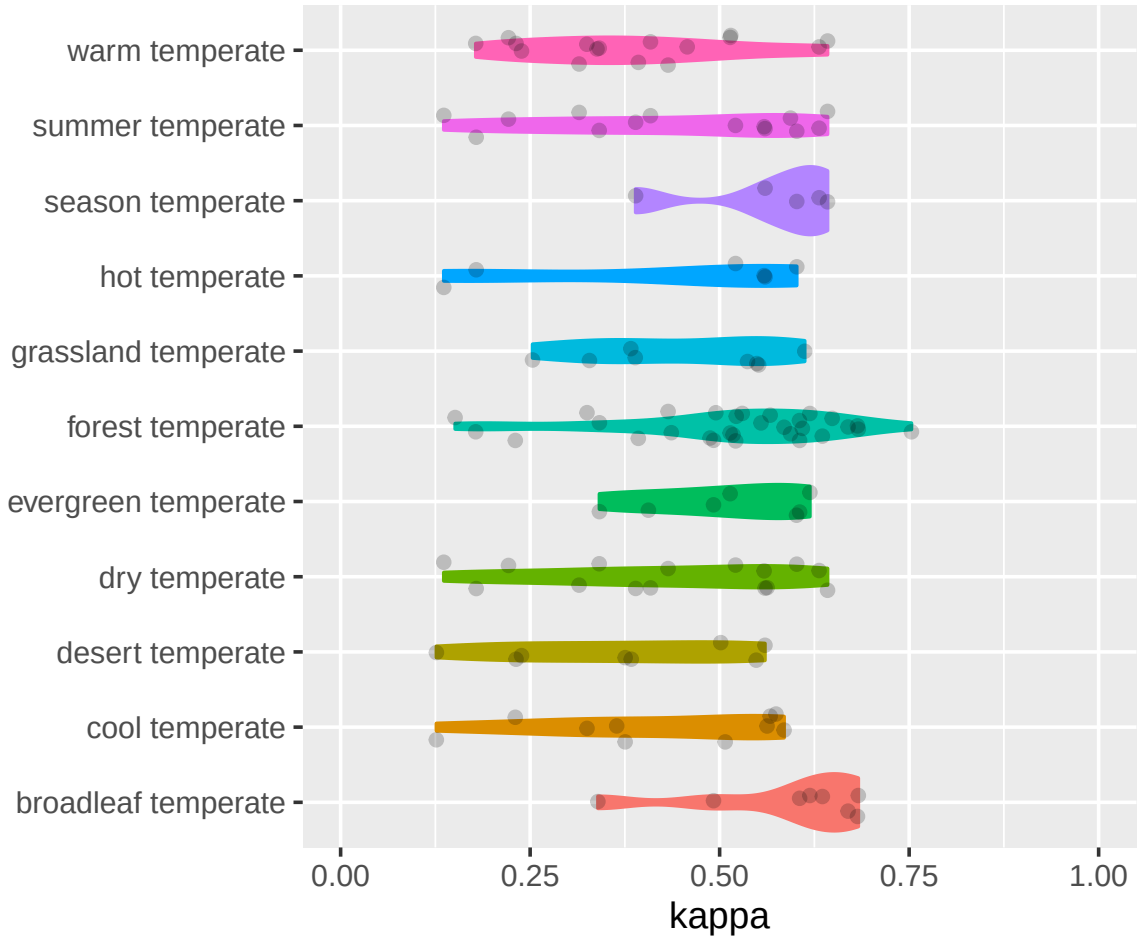

Figure S8: Model performance (κ values) in different biomes in temperate regions. For this analysis, all biomes that contain the attributes provided in the figure in their names were identified in the F31 biome maps. Then, the κ value was calculated for each biome (represented by the points in the figure).

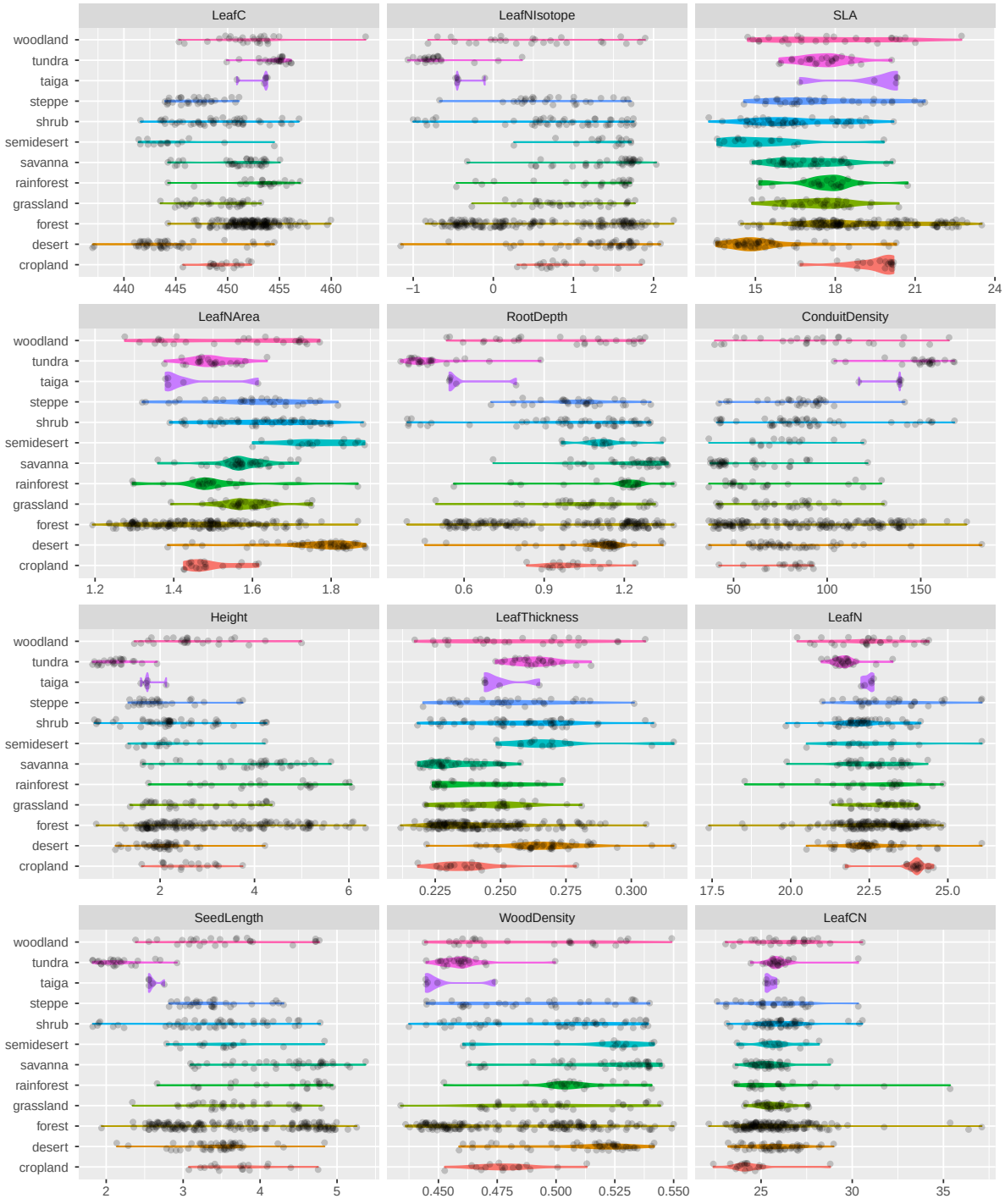

Figure S9: Mean trait values in different biomes selected by biome type. For this analysis, all biomes that contain the attributes provided in the figure in their names were identified in the F31 biome maps. Then, the mean trait values were calculated for each biome (represented by the points in the figure).

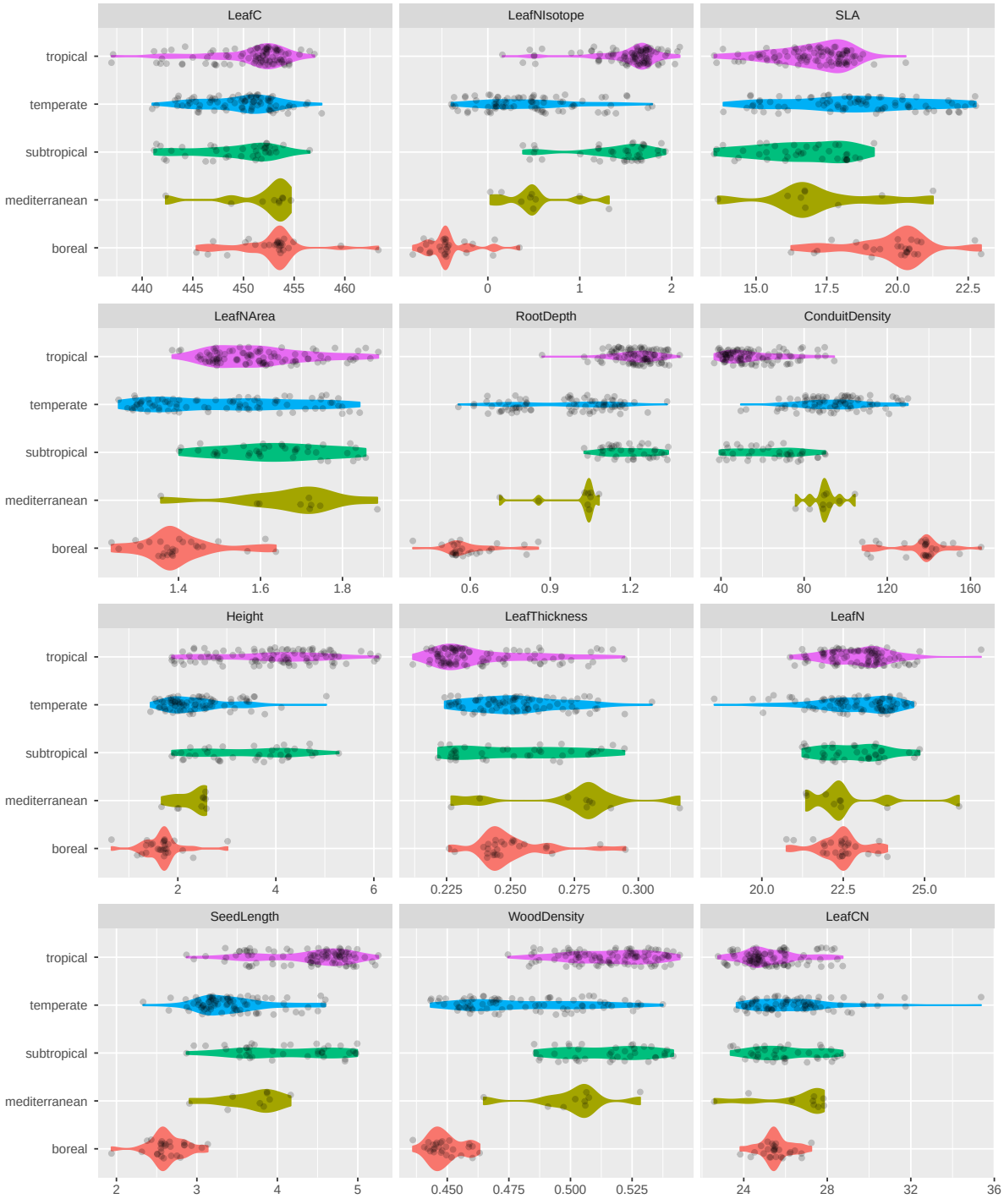

Figure S10: Mean trait values in different biomes selected by climate zone. For this analysis, all biomes that contain the attributes provided in the figure in their names were identified in the F31 biome maps. Then, the mean trait values were calculated for each biome (represented by the points in the figure).

Figure S11: Mean trait values in different forest types. For this analysis, all biomes that contain the attributes provided in the figure in their names were identified in the F31 biome maps. Then, the mean trait values were calculated for each biome (represented by the points in the figure).

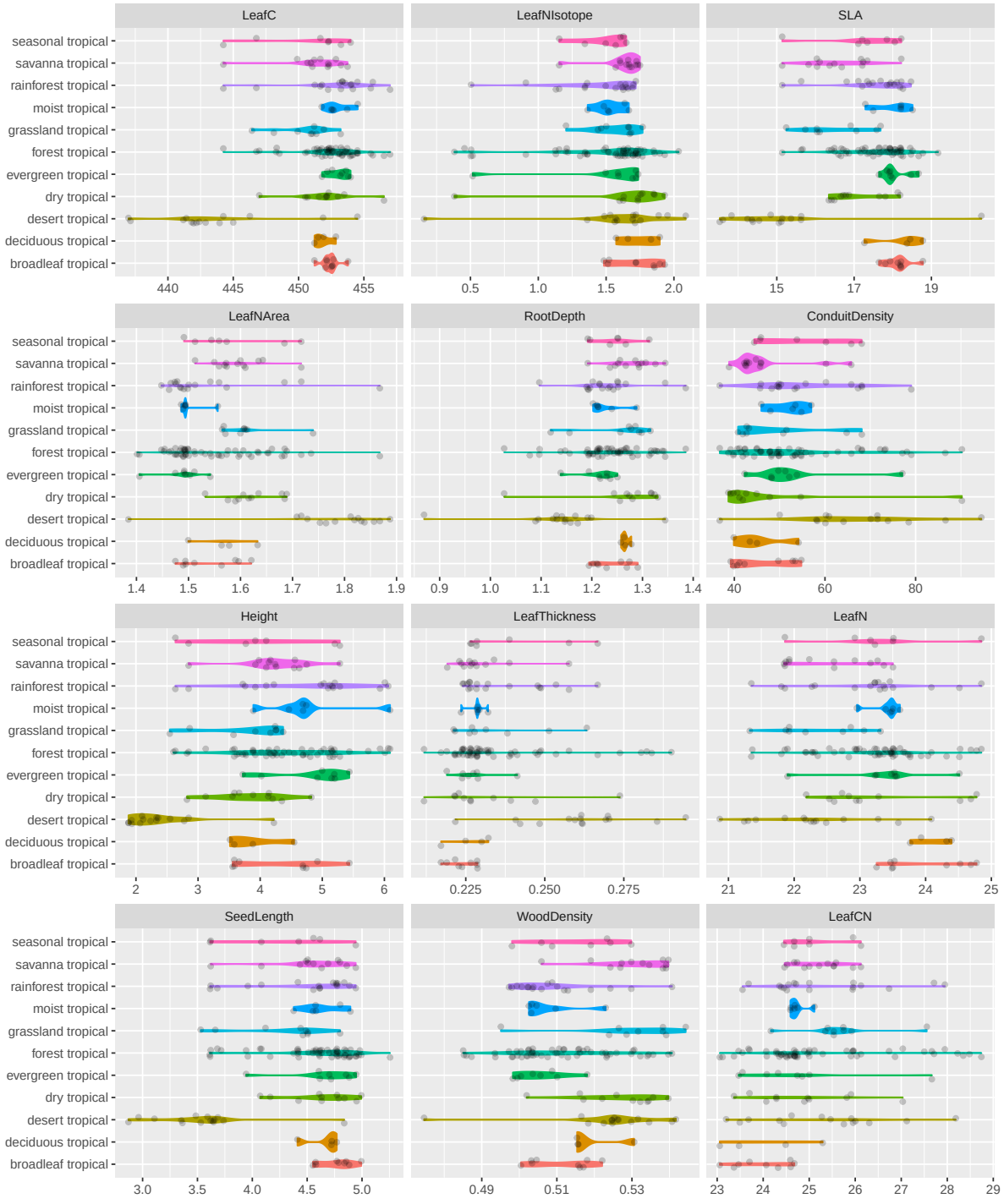

Figure S12: Mean trait values in different biomes in tropical regions. For this analysis, all biomes that contain the attributes provided in the figure in their names were identified in the F31 biome maps. Then, the mean trait values were calculated for each biome (represented by the points in the figure).

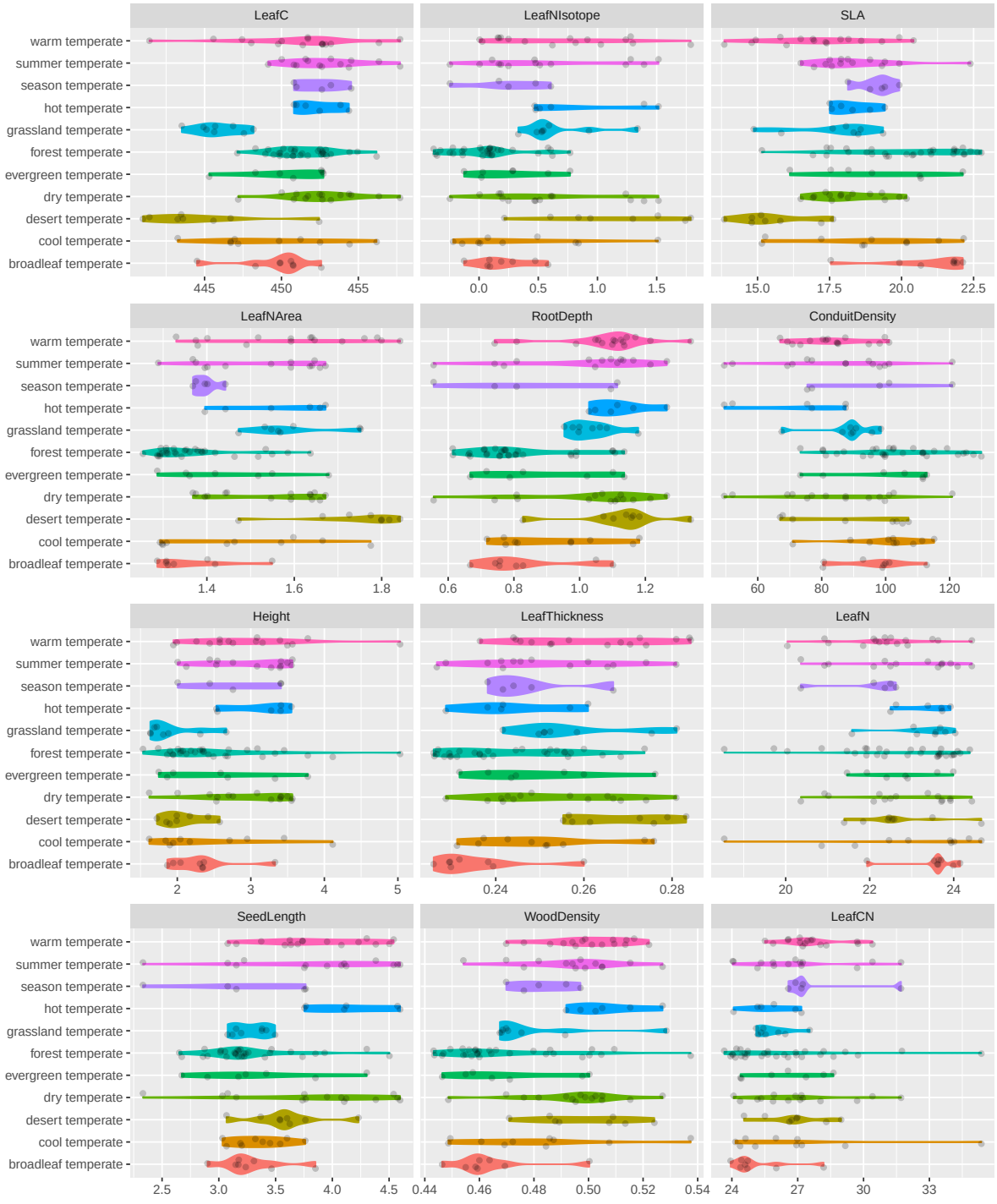

Figure S13: Mean trait values in different biomes in temperate regions. For this analysis, all biomes that contain the attributes provided in the figure in their names were identified in the F31 biome maps. Then, the mean trait values were calculated for each biome (represented by the points in the figure).

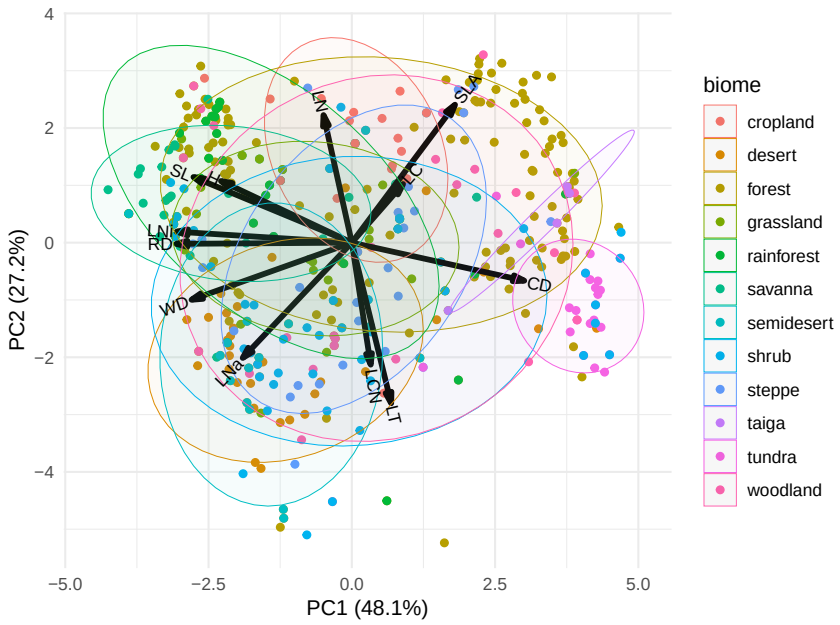

Figure S14: Principal component analysis of traits in different biome types. For the analysis, all biome names in the F31 biome maps (Fischer et al. 2022) containing different biome types were selected and mean traits were calculated. The PCA was calculated for these trait means. Attributes are represented by different colors. Each point represents one biome map in the F31 data.

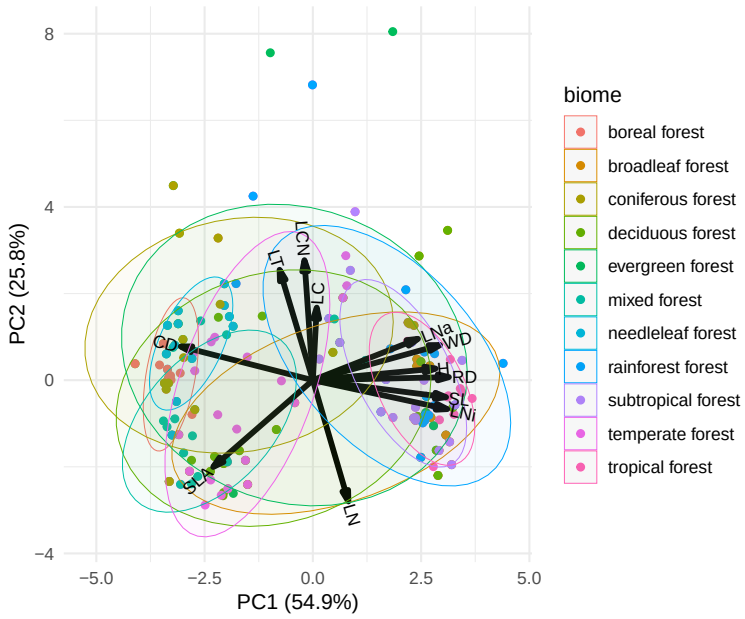

Figure S15: Principal component analysis of traits in different forest types. For the analysis, all biome names in the F31 biome maps (Fischer et al. 2022) containing different forest types were selected and mean traits were calculated. The PCA was calculated for these trait means. Attributes are represented by different colors. Each point represents one biome map in the F31 data.

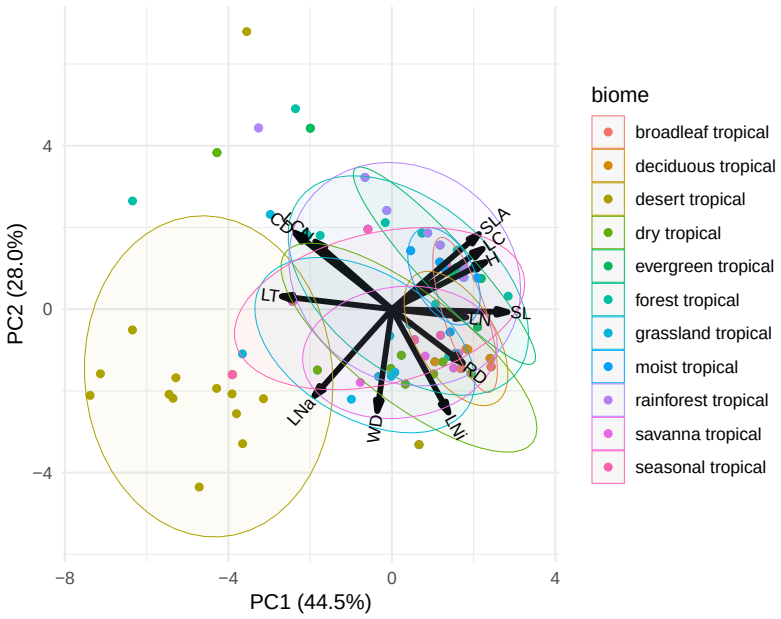

Figure S16: Principal component analysis of traits in different forest types. For the analysis, all biome names in the F31 biome maps (Fischer et al. 2022) containing different tropical biomes were selected and mean traits were calculated. The PCA was calculated for these trait means. Attributes are represented by different colors. Each point represents one biome map in the F31 data.

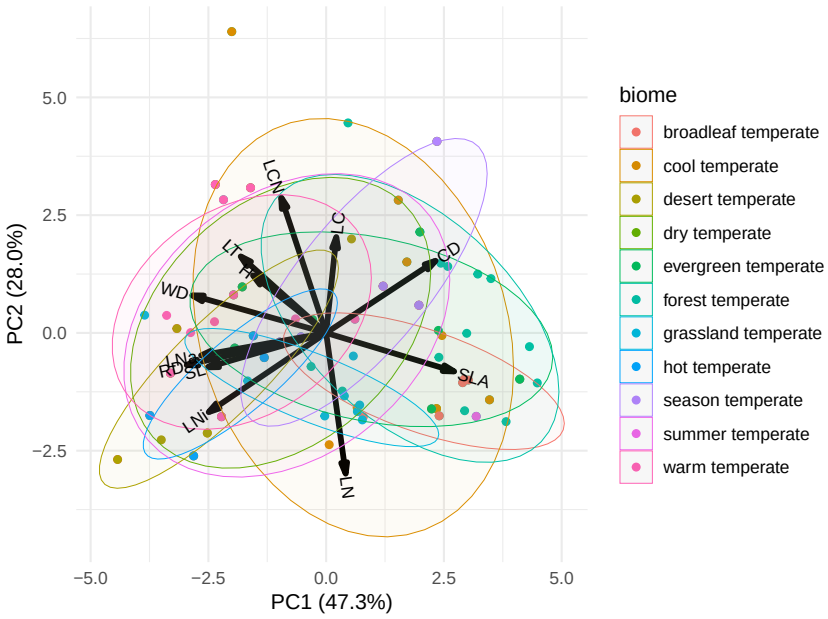

Figure S17: Principal component analysis of traits in different forest types. For the analysis, all biome names in the F31 biome maps (Fischer et al. 2022) containing different temperate were selected and mean traits were calculated. The PCA was calculated for these trait means. Attributes are represented by different colors. Each point represents one biome map in the F31 data.

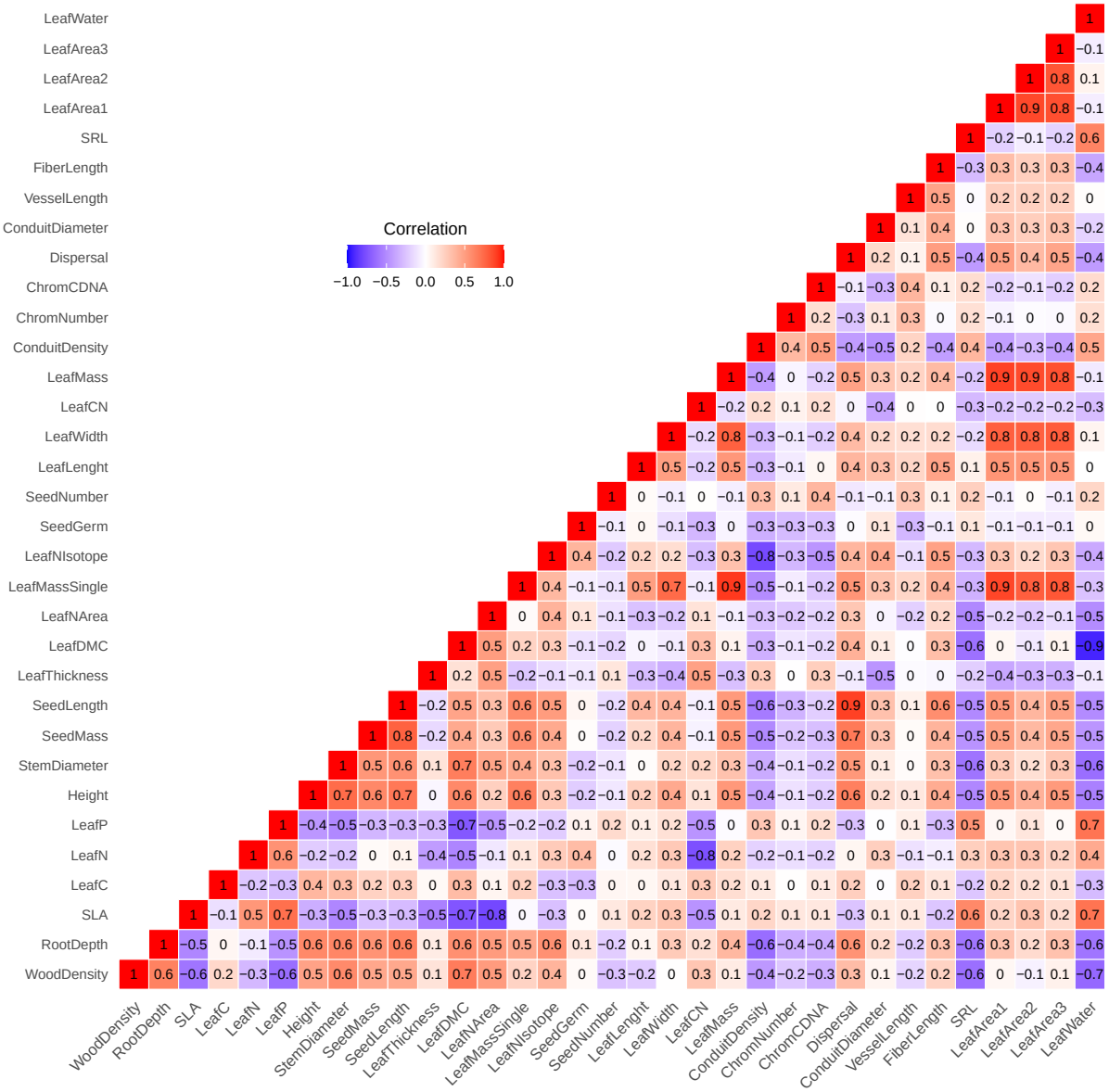

Figure S18: Correlation between all traits included in the analysis.

References

Fischer JC, Walentowitz A, Beierkuhnlein C (2022) The biome inventory - standardizing global biogeographical land units. Global Ecology and Biogeography, **31**, 2172–2183.

Kattge J, Bönisch G, Díaz S, et al. (2020) TRY plant trait database - enhanced coverage and open access. Global Change Biology, **26**, 119–188.