

Supplemental Table 1

Supplemental Table 1. CA axes 1-3 species scores. Only taxa present in at least 10% sites were selected for CA (n = 35 taxa). Results are given for temperate-cold biomes from North America (n = 2554 sites). Pollen taxa are ranking according to their scores.

Variable (pollen taxa)	CA axis 1 ($\lambda_1=0.345$)	Variable (pollen taxa)	CA axis 2 ($\lambda_2=0.136$)	Variable (pollen taxa)	CA axis 3 ($\lambda_3=0.119$)
Ericaceae	1.3617	Chenopodiaceae	3.3344	Chenopodiaceae	3.9212
<i>Picea</i> sp.	1.2233	Polygonaceae	3.2874	<i>Larix</i>	1.4799
<i>Alnus</i> sp.	1.1535	Rhamnaceae	1.5398	<i>Pinus</i> sp.	1.4581
Cyperaceae	1.0519	Tubuliflorae-Liguliflorae	1.5115	<i>Myrica gale</i>	1.3800
<i>Salix</i>	0.6453	Cyperaceae	1.3031	<i>Abies balsamea</i>	1.0684
<i>Artemisia</i>	0.6430	Aquifoliaceae	1.2103	Polygonaceae	0.9051
<i>Betula</i>	0.5880	Poaceae	1.1091	<i>Picea</i> sp.	0.8907
Rosaceae	0.4705	Rosaceae	1.0455	Aquifoliaceae	0.4037
<i>Larix</i>	0.3023	<i>Salix</i>	1.0162	<i>Corylus</i>	0.3940
Poaceae	0.0088	Ericaceae	0.9149	<i>Artemisia</i>	0.2199
<i>Abies balsamea</i>	-0.0345	<i>Carya</i>	0.9030	Tubuliflorae-Liguliflorae	0.2050
<i>Myrica gale</i>	-0.2418	<i>Myrica gale</i>	0.8417	<i>Populus</i> sp.	-0.0176
<i>Populus</i> sp.	-0.3776	Plantaginaceae	0.7641	<i>Ambrosia</i>	-0.0296
<i>Pinus</i> sp.	-0.3877	<i>Ambrosia</i>	0.3328	Cupressaceae	-0.1734
Tubuliflorae-Liguliflorae	-0.5475	<i>Quercus</i>	0.3201	<i>Betula</i>	-0.3303
Polygonaceae	-0.6418	<i>Juglans</i>	0.2720	<i>Alnus</i> sp.	-0.3403
<i>Rumex/Oxyria</i>	-0.7254	<i>Artemisia</i>	0.2544	<i>Quercus</i>	-0.4030
<i>Corylus</i>	-0.7768	<i>Platanus</i>	0.2417	<i>Carpinus/Ostrya</i>	-0.5057
Chenopodiaceae	-0.9098	<i>Alnus</i> sp.	-0.0126	<i>Ulmus</i>	-0.5342
Cupressaceae	-0.9193	<i>Rumex/Oxyria</i>	-0.2524	<i>Salix</i>	-0.5874
<i>Ambrosia</i>	-1.1779	<i>Pinus</i> sp.	-0.2661	<i>Acer</i> sp.	-0.5912
<i>Tsuga canadensis</i>	-1.2650	<i>Fraxinus</i> sp.	-0.2934	<i>Fraxinus</i> sp.	-0.7173
<i>Fagus</i>	-1.3326	<i>Ulmus</i>	-0.3512	<i>Tsuga canadensis</i>	-0.7948
<i>Carpinus/Ostrya</i>	-1.3426	<i>Populus</i> sp.	-0.4799	<i>Carya</i>	-0.8345
<i>Acer</i> sp.	-1.3447	<i>Betula</i>	-0.5487	Poaceae	-0.8906
<i>Fraxinus</i> sp.	-1.4205	<i>Carpinus/Ostrya</i>	-0.7650	Cyperaceae	-0.9150
<i>Ulmus</i>	-1.4592	Cupressaceae	-0.8436	<i>Tilia</i>	-0.9841
Aquifoliaceae	-1.4793	<i>Picea</i> sp.	-0.8980	Rhamnaceae	-1.0049
<i>Quercus</i>	-1.5493	<i>Tilia</i>	-0.9337	<i>Rumex/Oxyria</i>	-1.0934
<i>Tilia</i>	-1.5786	<i>Acer</i> sp.	-1.0251	<i>Juglans</i>	-1.1010
Plantaginaceae	-1.6488	<i>Corylus</i>	-1.0569	Ericaceae	-1.1856
<i>Juglans</i>	-1.7360	<i>Larix</i>	-1.4126	<i>Fagus</i>	-1.1906
<i>Platanus</i>	-1.8304	<i>Fagus</i>	-1.7641	<i>Platanus</i>	-1.4278
<i>Carya</i>	-1.8545	<i>Tsuga canadensis</i>	-1.8778	Rosaceae	-1.7616
Rhamnaceae	-1.8589	<i>Abies balsamea</i>	-2.2463	Plantaginaceae	-1.7768

Supplemental Table 2

Supplemental Table 2. Intra-set correlation matrix between CCA axes 1-3 and the 70 of climate and bioclimates variables. Reconstructed variables are outlined. Results are given for temperate-cold biomes from North America (n = 2554 sites). Climate and bioclimatic variables are ranking according to scores.

Variable	CCA axis 1 ($\lambda_1=0.329$)	Variable	CCA axis 2 ($\lambda_2=0.100$)	Variable	CCA axis 3 ($\lambda_3=0.091$)
taug	-0.5180	totsnopt	-0.2105	pjun	-0.1367
tsep	-0.5170	chill	-0.0952	pjja	-0.1277
tson	-0.5138	<u>mtwa-mtco</u>	<u>-0.0950</u>	pjul	-0.1276
toct	-0.5127	pnov	-0.0944	psep	-0.1184
tjul	-0.5115	pdec	-0.0847	paug	-0.1048
<u>tave</u>	<u>-0.5115</u>	pjanpann	-0.0816	poct	-0.0845
tjja	-0.5113	pdjf	-0.0799	pson	-0.0758
<u>mtwa</u>	<u>-0.5112</u>	pjan	-0.0560	toct	-0.0745
saug	-0.5101	papr	-0.0436	saug	-0.0696
<u>sja</u>	<u>-0.5078</u>	pson	-0.0380	tapr	-0.0685
apetpt	-0.5042	poct	-0.0343	tmax	-0.0641
tmam	-0.5042	pfeb	-0.0274	pmay	-0.0594
tapr	-0.5038	pmar	-0.0259	tson	-0.0588
sjul	-0.5025	pmam	-0.0222	<u>annp</u>	<u>-0.0587</u>
tnov	-0.5022	<u>annp</u>	<u>-0.0217</u>	tmay	-0.0581
tmay	-0.5011	tmax	-0.0080	tmam	-0.0581
tmar	-0.4990	miptdc	0.0018	<u>mtwa</u>	<u>-0.0566</u>
ssep	-0.4987	pmay	0.0033	taug	-0.0565
tmax	-0.4985	<u>mipt</u>	<u>0.0169</u>	tjul	-0.0561
apetptev	-0.4985	paug	0.0233	totsnopt	-0.0541
tjun	-0.4971	miptev	0.0235	tnov	-0.0536
tdjf	-0.4937	psep	0.0260	tjja	-0.0533
tdec	-0.4902	pjja	0.0443	tmar	-0.0482
aaetpt	-0.4865	pjul	0.0449	<u>gdd5</u>	<u>-0.0473</u>
sjun	-0.4856	saug	0.0487	tjun	-0.0470
tfeb	-0.4853	sjul	0.0508	<u>tave</u>	<u>-0.0464</u>
apetptdc	-0.4849	tnov	0.0530	apetptdc	-0.0460
pmay	-0.4827	tapr	0.0561	tsep	-0.0457
<u>mtco</u>	<u>-0.4810</u>	tjul	0.0561	sjul	-0.0452
aaetptev	-0.4804	<u>mtwa</u>	<u>0.0569</u>	apetpt	-0.0449
tjan	-0.4781	pjun	0.0578	gdd0	-0.0448
soct	-0.4718	tmay	0.0606	<u>sja</u>	<u>-0.0416</u>
aaetptdc	-0.4702	tmam	0.0615	apetptev	-0.0402
papr	-0.4638	tjja	0.0619	aaetptdc	-0.0394
pmam	-0.4572	<u>sja</u>	<u>0.0630</u>	aaetpt	-0.0353
gdd0	-0.4518	tjun	0.0639	aaetptev	-0.0327
sson	-0.4459	taug	0.0641	tfeb	-0.0308
tmin	-0.4370	tson	0.0644	tdjf	-0.0281
<u>gdd5</u>	<u>-0.4335</u>	toct	0.0651	sjan	-0.0270
<u>annp</u>	<u>-0.4062</u>	tmar	0.0659	miptdc	-0.0229
pjun	-0.3924	<u>tave</u>	<u>0.0711</u>	<u>mtwa-mtco</u>	<u>-0.0217</u>
smay	-0.3871	tdjf	0.0746	tdec	-0.0214
pmar	-0.3838	tdec	0.0785	pmam	-0.0189
psep	-0.3788	ssep	0.0790	pnov	-0.0161
pson	-0.371	tsep	0.0795	<u>mipt</u>	<u>-0.0156</u>
pjja	-0.3687	tfeb	0.0862	pjan	-0.0148
sjan	-0.3475	<u>mtco</u>	<u>0.0871</u>	<u>mtco</u>	<u>-0.0138</u>
paug	-0.3474	tjan	0.0894	sdec	-0.0105
pnov	-0.3443	sjun	0.0896	pdjf	-0.0102
sdjf	-0.3283	pjulpann	0.0962	tjan	-0.0100
pjul	-0.3279	soct	0.1044	miptev	-0.0097
poct	-0.3248	aaetpt	0.1118	sjun	-0.0033
pdjf	-0.3226	apetpt	0.1118	smay	-0.0016
pfeb	-0.3213	apetptev	0.1186	sdjf	-0.0009
pdec	-0.3186	aaetptev	0.1195	pdec	-0.0001
snov	-0.3128	sjan	0.1213	pjulpann	0.0001
sdec	-0.3003	sson	0.1219	tmin	0.0020
pjan	-0.2899	aaetptdc	0.1242	papr	0.0024
smam	-0.2312	apetptdc	0.1253	pfeb	0.0029
<u>mipt</u>	<u>-0.2094</u>	tmin	0.1270	pmar	0.0037
miptdc	-0.1783	smay	0.1276	sfeb	0.0196
sapr	-0.1773	gdd0	0.1475	ssep	0.0214
sfeb	-0.1729	sdec	0.1502	soct	0.0231
miptev	-0.1588	sdjf	0.1536	sson	0.0265
pjanpann	-0.0950	<u>gdd5</u>	<u>0.1624</u>	pjanpann	0.0300
smar	-0.0670	snov	0.1747	sapr	0.0330
totsnopt	0.0076	sfeb	0.1766	snov	0.0332
<u>mtwa-mtco</u>	<u>0.3732</u>	smam	0.2052	smam	0.0382
pjulpann	0.3842	smar	0.2245	chill	0.0435
chill	0.4860	sapr	0.2256	smar	0.0780

Information on variable name is given on "Variables" sheet

Supplemental Table 3

Supplemental Table 3. Marginal and conditional effects of the 70 climate and bioclimatic variables derived from forward selection in CCA. Reconstructed variables are outlined. Results are given for temperate-cold biomes from North America (n = 2554 sites). Climate and bioclimatic data are ranking according to scores.

Marginal effects		Conditional effects					
Variable	λ_j	Variable	λ_a	% variance	p-value	cum(λ_a)	cum (%var.)
tsep	0.278	tsep	0.278	39.60	0.005	0.278	39.15
taug	0.277	<u>gdd5</u>	<u>0.084</u>	<u>11.97</u>	<u>0.005</u>	<u>0.362</u>	<u>50.99</u>
toct	0.274	<u>sja</u>	<u>0.047</u>	<u>6.70</u>	<u>0.005</u>	<u>0.409</u>	<u>57.61</u>
tson	0.274	sjun	0.041	5.84	0.005	0.45	63.38
<u>tave</u>	<u>0.271</u>	tjan	0.027	3.85	0.005	0.477	67.18
tjul	0.270	totsnopt	0.021	2.99	0.005	0.498	70.14
<u>mtwa</u>	<u>0.270</u>	tfeb	0.020	2.85	0.005	0.518	72.96
apetpt	0.270	ssep	0.017	2.42	0.005	0.535	75.35
tja	0.270	chill	0.014	1.99	0.005	0.549	77.32
saug	0.269	pmar	0.014	1.99	0.005	0.563	79.30
apetptev	0.266	apetpt	0.010	1.42	0.005	0.573	80.70
<u>sja</u>	<u>0.266</u>	apetptev	0.010	1.42	0.005	0.583	82.11
tapr	0.263	tmay	0.010	1.42	0.005	0.593	83.52
tmam	0.263	toct	0.008	1.14	0.005	0.601	84.65
tnov	0.261	smay	0.008	1.14	0.005	0.609	85.77
sjul	0.261	pnov	0.006	0.85	0.005	0.615	86.62
tmay	0.260	<u>mtco</u>	<u>0.006</u>	<u>0.85</u>	<u>0.005</u>	<u>0.621</u>	<u>87.46</u>
tmar	0.258	tjul	0.005	0.71	0.005	0.626	88.17
ssep	0.257	tapr	0.005	0.71	0.005	0.631	88.87
tmax	0.257	tnov	0.005	0.71	0.005	0.636	89.58
tjun	0.255	pjun	0.005	0.71	0.005	0.641	90.28
apetptdc	0.255	sapr	0.004	0.57	0.005	0.645	90.85
tdjf	0.255	sjan	0.004	0.57	0.005	0.649	91.41
tdec	0.252	<u>annp</u>	<u>0.004</u>	<u>0.57</u>	<u>0.005</u>	<u>0.653</u>	<u>91.97</u>
aaetpt	0.252	pjul	0.004	0.57	0.005	0.657	92.54
chill	0.250	apetptdc	0.003	0.43	0.005	0.66	92.96
tfeb	0.248	smar	0.003	0.43	0.005	0.663	93.38
aaetptev	0.248	snov	0.003	0.43	0.005	0.666	93.80
sjun	0.247	pfeb	0.003	0.43	0.005	0.669	94.23
<u>mtco</u>	<u>0.244</u>	pdec	0.003	0.43	0.005	0.672	94.65
tjan	0.242	papr	0.003	0.43	0.005	0.675	95.07
pmay	0.241	pjanpann	0.002	0.28	0.005	0.677	95.35
aaetptdc	0.240	tmax	0.002	0.28	0.005	0.679	95.63
soct	0.236	aaetptev	0.002	0.28	0.005	0.681	95.92
gdd0	0.230	sdec	0.002	0.28	0.005	0.683	96.20
papr	0.224	aaetptdc	0.002	0.28	0.005	0.685	96.48
<u>gdd5</u>	<u>0.219</u>	tdec	0.002	0.28	0.005	0.687	96.76
pmam	0.218	aaetpt	0.002	0.28	0.005	0.689	97.04
sson	0.217	sjul	0.002	0.28	0.005	0.691	97.32
tmin	0.214	soct	0.002	0.28	0.005	0.693	97.61
pjun	0.181	tjun	0.002	0.28	0.005	0.695	97.89
<u>annp</u>	<u>0.180</u>	pjulpann	0.001	0.14	0.005	0.696	98.03
smay	0.171	sfeb	0.001	0.14	0.005	0.697	98.17
psep	0.166	taug	0.001	0.14	0.005	0.698	98.31
pjulpann	0.164	paug	0.001	0.14	0.005	0.699	98.45
pmar	0.161	pjan	0.001	0.14	0.005	0.700	98.59
<u>mtwa-mtco</u>	<u>0.160</u>	<u>mtwa</u>	<u>0.001</u>	<u>0.14</u>	<u>0.010</u>	<u>0.701</u>	<u>98.73</u>
pja	0.160	pmay	0.001	0.14	0.005	0.702	98.87
pson	0.158	<u>mipt</u>	<u>0.001</u>	<u>0.14</u>	<u>0.005</u>	<u>0.703</u>	<u>99.01</u>
paug	0.141	miptev	0.001	0.14	0.005	0.704	99.15
pnov	0.141	psep	0.001	0.14	0.005	0.705	99.30
sjan	0.138	tmin	0.001	0.14	0.005	0.706	99.44
snov	0.134	tmar	0.001	0.14	0.005	0.707	99.58
sdjf	0.134	gdd0	0.001	0.14	0.005	0.708	99.72
pjul	0.131	miptdc	0.001	0.14	0.010	0.709	99.86
poct	0.129	smam	0.001	0.14	0.005	0.710	100.00
pdjf	0.125	<u>tave</u>	-	-	-	-	-
pdec	0.123	tdjf	-	-	-	-	-
pfeb	0.120	tmam	-	-	-	-	-
sdec	0.116	tja	-	-	-	-	-
pjan	0.104	tson	-	-	-	-	-
smam	0.102	<u>mtwa-mtco</u>	-	-	-	-	-
sapr	0.090	sdjf	-	-	-	-	-
sfeb	0.065	saug	-	-	-	-	-
smar	0.065	sson	-	-	-	-	-
totsnopt	0.060	pdjf	-	-	-	-	-
<u>mipt</u>	<u>0.046</u>	pmam	-	-	-	-	-
miptdc	0.034	pja	-	-	-	-	-
pjanpann	0.032	pson	-	-	-	-	-
miptev	0.028	poct	-	-	-	-	-

λ_j : fit (eigenvalue with variable j only)

λ_a : additional fit (increase in eigenvalue)

cum(λ_a): cumulative total eigenvalues λ_a

p-value: significance level of the effect obtained from Monte Carlo permutations under the reduced model with 199 random permutations

Information on variable name is given on "Variables" sheet