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Supplementary Information for

Asynchronous nitrogen supply and demand produce non-linear plant allocation responses to warming and elevated CO_2

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Fig. S1. SMARTX transect showing aboveground infrared heaters (foreground) and open-top elevated CO_2 (eCO_2) chamber (background). Heating cables extend 1.5 m into the soil and are located every 50 cm.

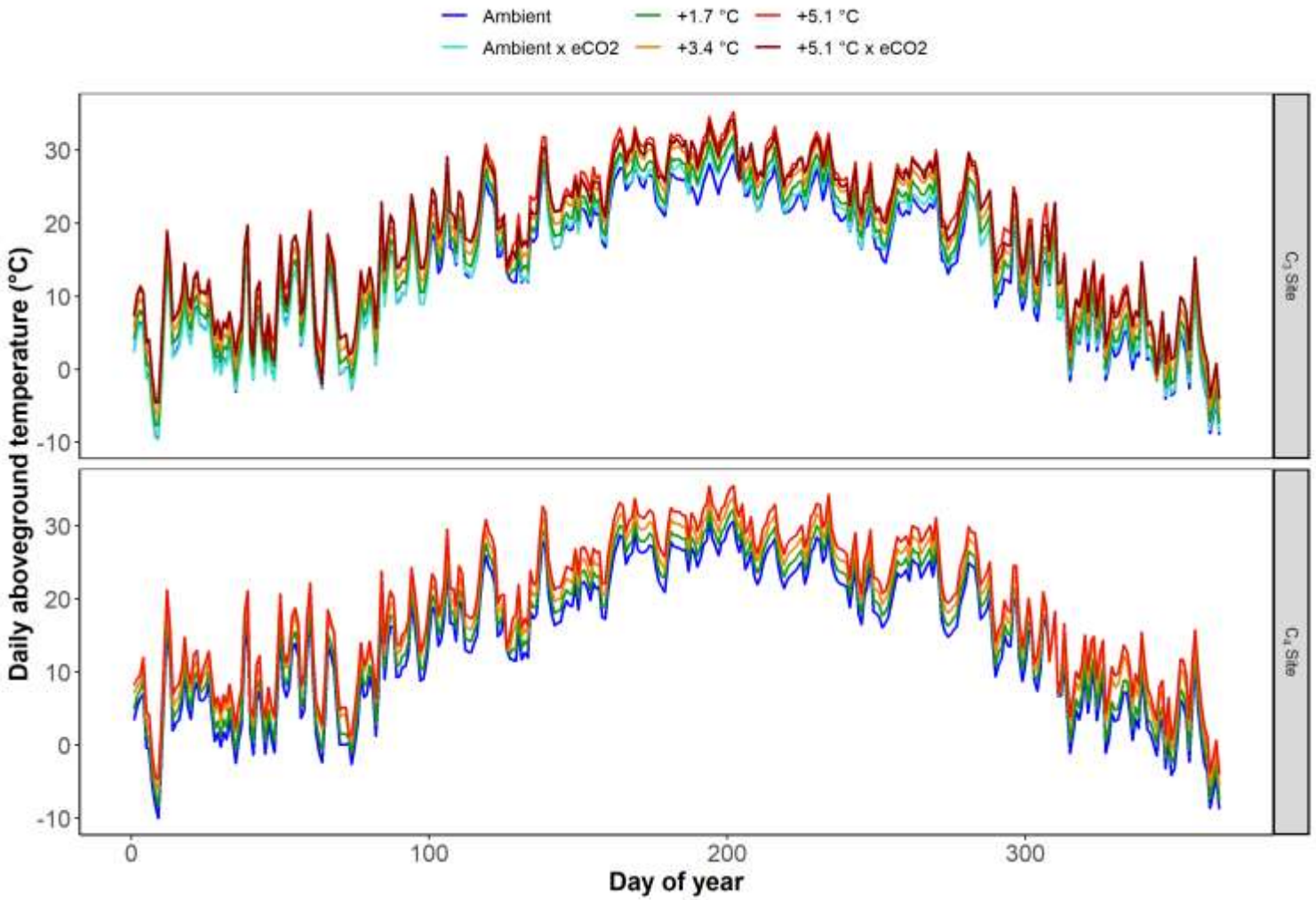

Fig. S2. Daily aboveground temperature in 2017 from each SMARTX treatment. Lines are the means of three replicate plots. Standard error is not shown because it is not visible at this scale.

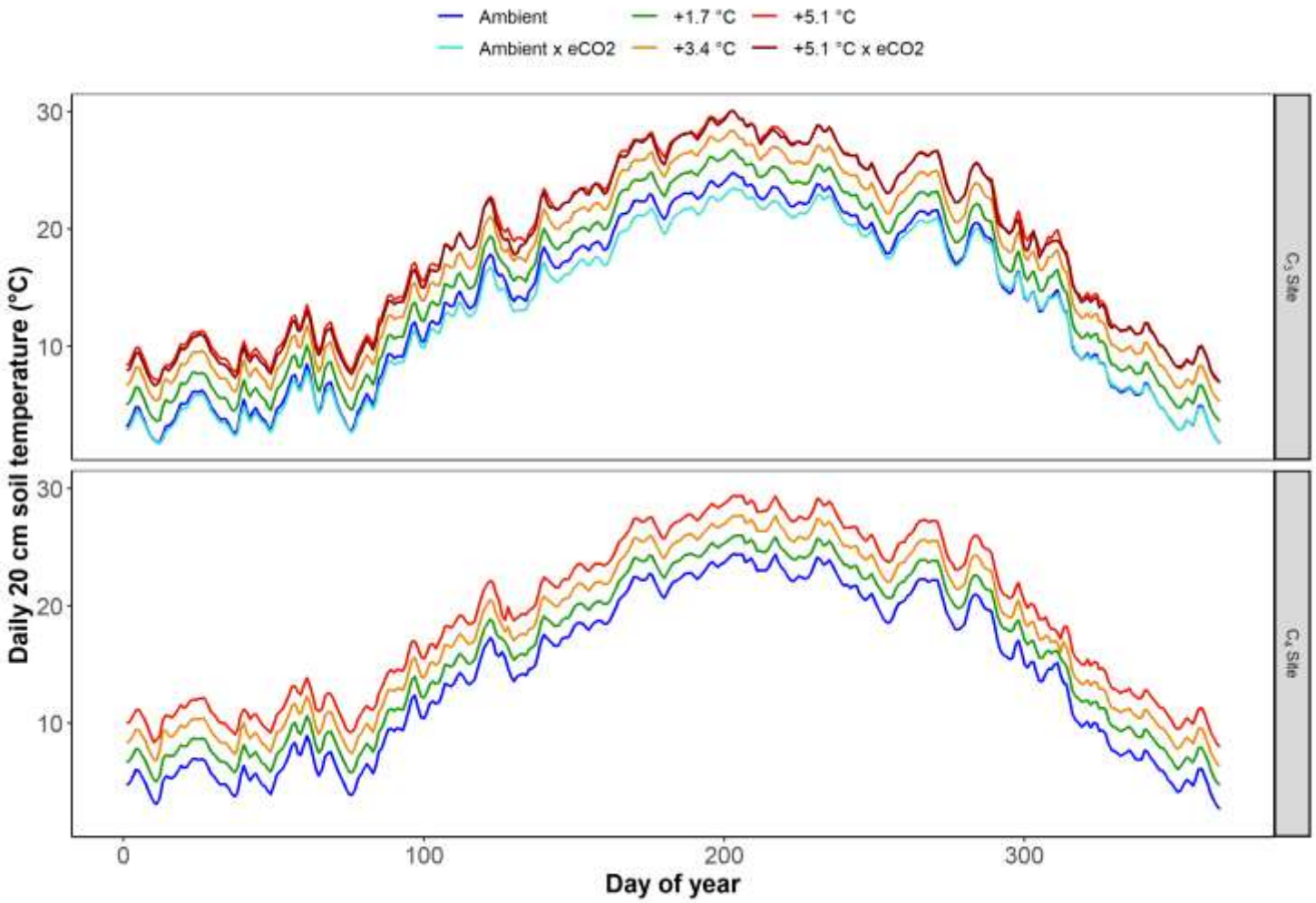

Fig. S3. Daily soil temperature in 2017 measured at 20 cm depth from each SMARTX treatment. Lines are the means of three replicate plots. Standard error is not shown because it is not visible at this scale.

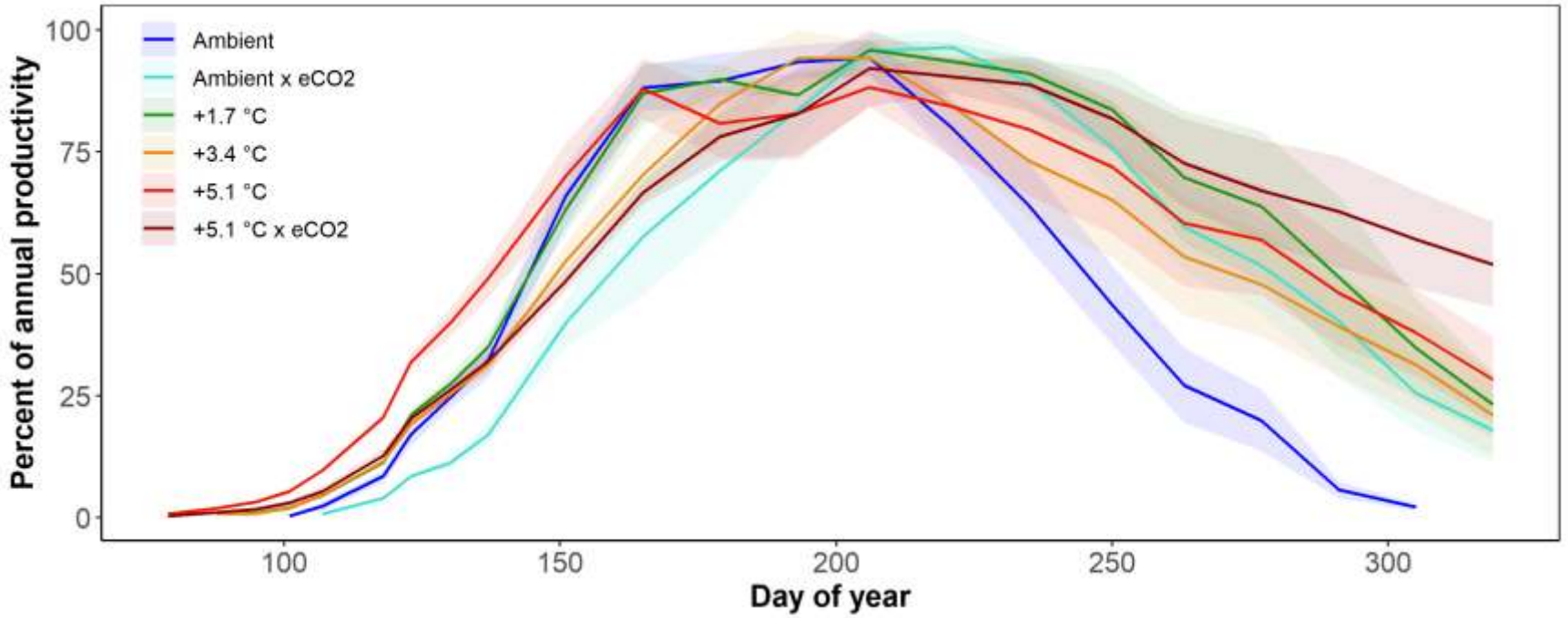

Fig. S4. Percent of total annual productivity that was present in SMARTX plots each week. Lines are the means of three replicate plots and shading is ± 1 standard error.

Table S1. Type III ANOVA tables for mixed effects models in the C_3 community with temperature treatment as a fixed effect and year and transect as random effects. *P*-values calculated using Satterthwaite's method.

Response	Sum Sq	Mean Sq	Num df	Den df	*F*	*P*
Total NPP	32559	10853	3	15	1.670	0.216
Above NPP	40456	13485	3	15	1.968	0.162
Belowground NPP	24774	8258	3	15	4.637	0.017
Root-to-shoot ratio	0.3857	0.1252	3	15	4.524	0.019
Plant N[‡]	11876	3958.6	3	8	0.7315	0.562
Porewater NH_4	46846	15614	3	15	3.924	0.030

[‡] Based on 2017 data only.

Table S2. Mixed effects model results of biomass and porewater NH_4^+ response variables in the C_3 community, as predicted by warming treatment (reference category: ambient temperature).

Response	Fixed effects terms	Estimate	SE	df	*t*	*P*
Total NPP	Intercept (ambient)	495.5	35.27	19	14.05	<0.001
	+1.7 °C	74.67	46.54	15	1.604	0.129
	+3.4 °C	64.13	46.54	15	1.378	0.188
	+5.1 °C	99.93	46.54	15	2.147	0.049
Above NPP	Intercept (ambient)	423.8	46.41	12	9.131	<0.001
	+1.7 °C	-5.183	47.79	15	-0.108	0.915
	+3.4 °C	40.55	47.79	15	0.849	0.410
	+5.1 °C	97.33	47.79	15	2.037	0.059
Belowground NPP	Intercept (ambient)	71.72	21.80	14	3.289	0.005
	+1.7 °C	79.82	24.37	15	3.277	0.005
	+3.4 °C	23.58	24.37	15	0.968	0.348
	+5.1 °C	2.583	24.37	15	0.106	0.917
Root-to-shoot ratio	Intercept (ambient)	0.182	0.091	12	2.008	0.066
	+1.7 °C	0.287	0.096	15	2.983	0.009
	+3.4 °C	0.061	0.096	15	0.637	0.534
	+5.1 °C	-0.035	0.096	15	-0.364	0.721
Plant N[‡]	Intercept (ambient)	409.7	42.47	8	9.647	<0.001
	+1.7 °C	65.57	60.06	8	1.092	0.307
	+3.4 °C	61.50	60.06	8	1.024	0.336
	+5.1 °C	83.33	60.06	8.00	1.387	0.203
Porewater NH_4	Intercept (ambient)	176.0	27.11	19	6.494	<0.001
	+1.7 °C	-62.15	36.42	15	-1.707	0.108
	+3.4 °C	25.02	36.42	15	0.687	0.503
	+5.1 °C	58.60	36.42	15	1.609	0.128

[‡] Based on 2017 data only.

Table S3. Type III ANOVA tables for mixed effects models in the C_4 community with temperature treatment as a fixed effect and year and transect as random effects. *P*-values calculated using Satterthwaite's method.

Response	Sum Sq	Mean Sq	Num df	Den df	*F*	*P*
Total NPP	24199	8066	3	15	0.617	0.615
Above NPP	16936	5646	3	15	0.355	0.786
Belowground NPP	1226.8	408.9	3	15	0.431	0.734
Root-to-shoot ratio	0.0192	0.006	3	15	0.359	0.784
Porewater NH_4	13356	4452	3	15	3.28	0.050

Table S4. Mixed effects model results of biomass and porewater NH_4^+ response variables in the C_4 community, as predicted by warming treatment (reference category: ambient temperature).

Response	Fixed effects terms	Estimate	SE	df	*t*	*P*
Total NPP	Intercept (ambient)	561.2	75.59	9	7.424	<0.001
	+1.7 °C	24.32	66.00	15	0.368	0.718
	+3.4 °C	-52.08	66.00	15	-0.789	0.442
	+5.1 °C	-45.52	66.00	15	-0.690	0.501
Above NPP	Intercept (ambient)	435.0	71.73	11	6.064	<0.001
	+1.7 °C	15.55	72.79	15	0.214	0.834
	+3.4 °C	-51.37	72.79	15	-0.706	0.491
	+5.1 °C	-34.15	72.79	15	-0.469	0.646
Belowground NPP	Intercept (ambient)	126.2	15.41	17	8.192	<0.001
	+1.7 °C	8.800	17.78	15	0.495	0.628
	+3.4 °C	-0.717	17.78	15	-0.040	0.968
	+5.1 °C	-11.37	17.78	15	-0.639	0.532
Root-to-shoot ratio	Intercept (ambient)	0.296	0.055	19	5.343	<0.001
	+1.7 °C	0.078	0.077	15	1.105	0.326
	+3.4 °C	0.051	0.077	15	0.666	0.515
	+5.1 °C	0.036	0.077	15	0.465	0.649
Porewater NH_4	Intercept (ambient)	297.8	25.69	8	11.591	<0.001
	+1.7 °C	-7.550	21.27	15	-0.355	0.728
	+3.4 °C	-52.03	21.27	15	-2.446	0.027
	+5.1 °C	-49.18	21.27	15	-2.312	0.035

Table S5. Mean values per temperature treatment and year (visually displayed in Figures 1, 2, 3, and 4 in the main text). Means within a given year that do not share a letter are significantly different at $\alpha = 0.05$.

C_3 community								
	2017				**2018**			
Temperature	**Amb**	**+1.7 °C**	**+3.4 °C**	**+5.1 °C**	**Amb**	**+1.7 °C**	**+3.4 °C**	**+5.1 °C**
Total NPP	464.9^{a}	528.1^{a}	494.7^{a}	567.8^{a}	526.2^{a}	612.2^{a}	624.6^{a}	623.1^{a}
Above NPP	367.1^{a}	320.6^{a}	359.0^{a}	479.5^{a}	480.5^{a}	516.6^{a}	569.7^{a}	562.8^{a}
Below NPP	97.8^{a}	207.5^{b}	135.7^{ab}	88.3^{a}	45.7^{a}	95.6^{a}	54.9^{a}	60.3^{a}
Root-to-shoot	0.269^{a}	0.732^{b}	0.392^{ab}	0.190^{a}	0.096^{a}	0.205^{a}	0.095^{a}	0.105^{a}
Plant N	409.7^{a}	475.3^{a}	471.2^{a}	493.1^{a}	--	--	--	--
NH_4	197.7^{ab}	126.0^{a}	181.1^{ab}	217.3^{b}	154.3^{a}	101.8^{a}	221.1^{a}	252.0^{a}
C_4 community								
	2017				**2018**			
Temperature	**Amb**	**+1.7 °C**	**+3.4 °C**	**+5.1 °C**	**Amb**	**+1.7 °C**	**+3.4 °C**	**+5.1 °C**
Total NPP	483.3^{b}	420.6^{ab}	381.9^{ab}	329.4^{a}	639.0^{a}	750.4^{a}	636.2^{a}	701.9^{a}
Above NPP	377.8^{b}	285.0^{ab}	290.0^{ab}	232.8^{a}	492.1^{a}	616.0^{a}	477.0^{a}	568.8^{a}
Below NPP	105.5^{ab}	135.6^{b}	92.1^{a}	96.6^{a}	146.9^{a}	134.4^{a}	158.9^{a}	133.1^{a}
Root-to-shoot	0.287^{a}	0.488^{b}	0.333^{ab}	0.421^{ab}	0.305^{a}	0.261^{a}	0.361^{a}	0.243^{a}
NH_4	263.8^{a}	255.4^{a}	208.7^{a}	218.5^{a}	331.8^{a}	325.1^{a}	282.9^{a}	278.8^{a}

Table S6. Type III ANOVA tables for mixed effects models in the C_3 community with temperature treatment and CO_2 treatment as fixed effects and year and transect as random effects. *P*-values calculated using Satterthwaite's method.

Response	Factor	Sum Sq	Mean Sq	Num df	Den df	*F*	*P*
Total NPP	Temp	33153	33153	1	20	4.188	0.054
	eCO_2	110378	110378	1	20	13.94	0.001
	Temp × eCO_2	3932	3932	1	20	0.497	0.489
Above NPP	Temp	17664	17664	1	15	2.730	0.119
	eCO_2	12344	12344	1	15	1.908	0.188
	Temp × eCO_2	11133	11133	1	15	1.720	0.209
Belowground NPP	Temp	2416	2416	1	15	1.464	0.245
	eCO_2	48925	48925	1	15	29.65	<0.001
	Temp × eCO_2	1834	1834	1	15	1.111	0.309
Root-to-shoot ratio	Temp	0.0039	0.0039	1	15	0.448	0.513
	eCO_2	0.1697	0.1697	1	15	19.50	<0.001
	Temp × eCO_2	0.0220	0.0220	1	15	2.523	0.133
Plant N[‡]	Temp	580	580	1	8	0.036	0.854
	eCO_2	129086	129086	1	8	8.078	0.022
	Temp × eCO_2	14463	14463	1	8	0.905	0.369
Porewater NH_4	Temp	63191	63191	1	20	10.86	0.004
	eCO_2	31472	31472	1	20	5.410	0.031
	Temp × eCO_2	11629	11629	1	20	1.999	0.173

[‡] Based on 2017 data only.

Table S7. Mixed effects model results of biomass and porewater NH_4^+ response variables in the C_3 community, as predicted by warming treatment and CO_2 treatment (reference category: ambient temperature, ambient CO_2).

Response	Fixed effects terms	Estimate	SE	df	*t*	*P*
Total NPP	Intercept (ambient)	495.5	36.32	20	13.64	<0.001
	+5.1 °C	99.93	51.37	20	1.945	0.066
	eCO_2	161.2	51.37	20	3.139	0.005
	+5.1 °C × *e*CO_2	-51.20	72.65	20	-0.705	0.489
Above NPP	Intercept (ambient)	423.8	35.69	18	11.87	<0.001
	+5.1 °C	97.33	46.44	15	2.096	0.053
	eCO_2	88.43	46.44	15	1.904	0.076
	+5.1 °C × *e*CO_2	-86.15	65.68	15	-1.312	0.209
Belowground NPP	Intercept (ambient)	71.72	24.49	10	2.928	0.014
	+5.1 °C	2.583	23.45	15	0.110	0.914
	eCO_2	72.82	23.45	15	3.105	0.007
	+5.1 °C × *e*CO_2	34.97	33.17	15	1.05	0.308
Root-to-shoot ratio	Intercept (ambient)	0.182	0.061	9	2.976	0.015
	+5.1 °C	-0.035	0.054	15	-0.650	0.526
	eCO_2	0.108	0.054	15	1.999	0.064
	+5.1 °C × *e*CO_2	0.121	0.076	15	1.589	0.133
Plant N[‡]	Intercept (ambient)	409.7	72.98	8	5.614	<0.001
	+5.1 °C	83.33	103.2	8	0.807	0.443
	eCO_2	276.9	103.2	8	2.682	0.028
	+5.1 °C × *e*CO_2	-138.9	146.0	8	-0.951	0.369
Porewater NH_4	Intercept (ambient)	176.0	31.14	20	5.653	<0.001
	+5.1 °C	58.6	44.04	20	1.331	0.198
	eCO_2	-116.4	44.04	20	-2.644	0.016
	+5.1 °C × *e*CO_2	88.05	62.28	20	1.414	0.172

[‡] Only using 2017 data.

Table S8. Mean values per temperature x CO_2 treatment and year (visually displayed in Figures 1, 2 and 4 in the main text). Different letters indicate significant (at $\alpha = 0.05$) effects of elevated CO_2 within a temperature treatment.

	2017				**2018**			
	Ambient		**+5.1 °C**		**Ambient**		**+5.1 °C**	
	Amb CO_2	**Elev CO_2**	**Amb CO_2**	**Elev CO_2**	**Amb CO_2**	**Elev CO_2**	**Amb CO_2**	**Elev CO_2**
Total NPP	464.9[a]	704.9[b]	567.8[a]	716.8[b]	526.2[a]	608.6[a]	623.1[a]	694.2[a]
Above NPP	367.1[a]	524.4[b]	479.5[a]	464.1[a]	480.5[a]	500.1[a]	562.8[a]	582.8[a]
Below NPP	97.8[a]	180.5[b]	88.3[a]	252.8[b]	45.7[a]	108.5[b]	60.3[a]	111.4[a]
Root-to-shoot	0.269[a]	0.353[a]	0.190[a]	0.560[b]	0.096[a]	0.227[b]	0.105[a]	0.192[a]
Plant N	409.7[a]	686.6[b]	493.1[a]	631.1[b]	--	--	--	--
NH_4	197.7[a]	76.7[b]	217.3[b]	152.3[a]	154.3[a]	42.5[b]	252.0[a]	260.2[a]