

Supplementary Information for

Multiple constraints cause positive and negative feedbacks limiting grassland soil CO₂ efflux under CO₂ enrichment

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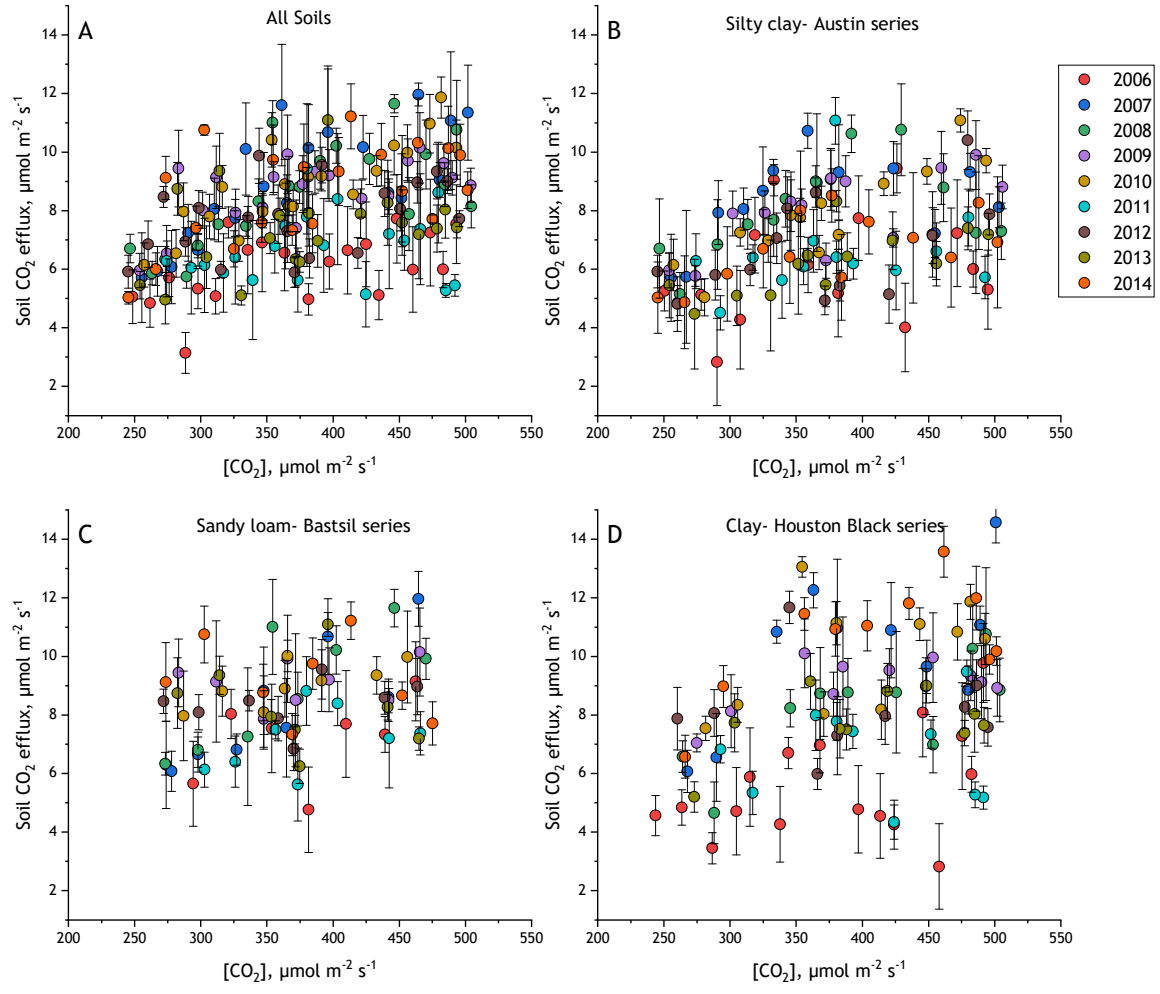


Figure S1. Soil CO₂ efflux as a function of CO₂ concentration in each year of the experiment. A) averaged across soils; B-D) for each soil series. Means ± 1SE.



Figure S2. Method for selective application of glyphosate to remove individual plants.

We painted glyphosate solution on individual plants we sought to remove using sponges attached to kitchen tongs. The sponges were dipped in glyphosate solution and then squeezed to remove excess to avoid dripping glyphosate on the soil. We painted as much of the targeted individual as practical without touching neighboring species. We left painted individuals in place to allow the glyphosate to transport belowground and usually could not later find or remove their dead remains. This technique minimized the amount of glyphosate used and potential phosphorus addition to communities.

Table S1. Linear regression models and coefficients of determination (R^2) for regressions plotted in Figures 1 and 2. J_{CO_2} : soil CO_2 efflux; ANPP: aboveground net primary productivity; Ψ_{soil} : soil water potential for 0-40 cm; PPFD: ground-level canopy light availability; exp(H): effective species richness.

Response	Soil	Model	R^2	p-value
J_{CO_2}	Silty Clay	$y = 7.58 - 138.20e^{(-0.0165*CO_2)}$	0.10	0.0013
	Sandy loam	$y = 5.68 + 0.00777*CO_2$	0.09	0.0133
	Clay	$y = 4.98 + 0.00966*CO_2$	0.12	0.0014
ANPP	All soils	$y = 107.47 + 0.82831*CO_2$	0.18	<0.0001
	Silty Clay	$y = 32.86 + 0.83264*CO_2$	0.26	<0.0001
	Sandy loam	$y = 79.72 + 1.10844*CO_2$	0.27	<0.0001
	Clay	$y = 272.3 + 0.50266*CO_2$	0.1	0.0044
Ψ_{soil}	Silty Clay	$y = -0.43 + 0.00028*CO_2$	0.14	<0.0001
	Sandy loam	$y = -0.45 + 0.00089*CO_2$	0.26	<0.0001
	Clay	$y = -2.79 + 0.00339*CO_2$	0.14	0.0006
PPFD	All soils	$y = 923.61 + -1.04739*CO_2$	0.06	0.0001
exp(H)	All soils	$y = 2.51 + 0.00091*CO_2$	0.01	0.1262
	Silty Clay	$y = 1.46 + 0.00357*CO_2$	0.18	<0.0001
	Sandy loam	$y = 4.71 + -0.00606*CO_2$	0.37	<0.0001
	Clay	$y = 3.67 + -0.00102*CO_2$	0.02	0.2409
Species turnover	Silty Clay	$y = 0.089 + 0.001*\delta CO_2$	0.18	<0.0001
	Sandy loam	$y = 0.121 + 0.00091*\delta CO_2$	0.12	<0.0001
	Clay	$y = 0.178 + 0.0001*\delta CO_2$	0.001	0.2192

Table S2. Linear mixed model analyses of soil CO₂ efflux in relation to soil, CO₂ enrichment, and the soil x CO₂ interaction. Soil effects were modelled using two quantitative variables, % clay and the %clay:%sand ratio, and as the original categorical variable as in Table 1. A,B, and H values refer to the assigned textures for Austin, Bastil, and Houston series, respectively.

Effect	% Clay			%Clay:%Sand ratio			Original categorical analysis		
	F Value	Pr > F	AIC	F Value	Pr > F	AIC	F Value	Pr > F	AIC
	A=43 B=9 H=53			A=3.58 B=0.13 H=5.2					
Soil	6.9	0.0134	306	4.9	0.0350	241	9.0	0.0010	222
CO2	2.4	0.1238		1.1	0.3036		0.1	0.7280	
Soil x CO2	6.5	0.0113		5.2	0.0234		4.6	0.0113	
Year effects		> 0.58			> 0.65			> 0.41	

Table S3. Partitioning the direct and indirect effects of the CO₂ responses in species turnover, effective species richness (exp(H)), soil water potential (Ψ_{soil}), and aboveground net primary productivity (ANPP) on the CO₂ response in soil CO₂ efflux rates, J_{CO_2} . Total effects are depicted in Figure 4, and direct effects correspond to paths depicted in Figure 5.

		Effects on CO ₂ response of J_{CO_2}					
	Path Variable	Direct	p value	Indirect	p value	Total	p value
Silty clay	Turnover	1.859	0.0478	0.307	0.6429	2.165	0.0033
	exp(H)	-1.295	0.0224	-0.081	0.6686	-1.376	0.0132
	Ψ_{Soil}	2.323	0.0228	0.252	0.6463	2.574	0.0052
	ANPP	0.191	0.6387			0.191	0.6387
Sandy loam	Turnover	0.027	0.8923	0.663	0.0017	0.690	0.0003
	exp(H)	0.874	0.0017	-0.362	0.066	0.511	0.0139
	Ψ_{Soil}			-0.309	0.3052	-0.309	0.3052
	ANPP	0.901	0.0003			0.901	0.0003
Clay	Turnover			0.324	0.1520	0.324	0.1520
	exp(H)			0.265	0.244	0.265	0.2441
	Ψ_{Soil}	-0.039	0.9069	0.056	0.7540	0.017	0.9642
	ANPP	0.520	0.0677			0.520	0.0677