APPENDIX

Time Series Regression Models

To calculate the sensitivity of soil CO_2 concentrations to fluctuations in soil moisture and soil temperature, we fit simple time series linear regression models of the form

$$CO_{2t} = \beta_0 + \beta_1 \left(Moisture_t\right) + \beta_2 \left(Temp_t\right) + \beta_3 \left(Trend\right) + e_t$$

where we interpreted β_1 and β_2 as the sensitivity of CO_2 to moisture and temperature fluctuations, respectively; β_3 is the parameter describing temporal trend in CO_2; and e_t is the residual error. We evaluated two important assumptions in our analyses. First, soil moisture and soil temperature did not covary during our rainfall variability experiment (r = -0.08, P = 0.40). Second, because data in the time series are not independent, it is necessary to check that the correlation structure of the residuals meet the white-noise assumption of the linear model. We tested this assumption using a Ljung-Box test (Ljung & Box 1978) implemented in R 2.11 (R Development Core Team 2010). The Ljung-Box procedure tests the null hypothesis of temporal independence of a time series by assessing whether the autocorrelations are different from zero.

None of the Ljung-Box tests were significant at the 0.05 level (Table S1), but some were marginally significant (i.e., +P, HV and –P, HV). Therefore, we refit the time series using autoregressive models (i.e., AR1) of the form

$$y_t = \beta_0 + \rho \left(y_{t-1}\right) + \beta_1 \left(x_{Moist,t} - \rho x_{Moist,t-1}\right) + \beta_2 \left(x_{Temp,t} - \rho x_{Temp,t-1}\right) + \beta_3 \left(Trend\right) + e_t.$$

where y_t is CO_2; β_0 is the intercept; ρ is the autocorrelation coefficient describing the proportion of error, *e*, from the previous time step, $_{t-1}$, that affects the prediction of y_t; β_1 and β_2 are parameters that describe the sensitivity of CO_2 to moisture and temperature fluctuations, respectively; and β_3 is the parameter describing temporal trend in CO_2.

The parameter estimates of the AR1 models are reported in Table S2 and the fits are shown in Fig. S1. Results from Ljung-Box tests indicated that there was no remaining autocorrelation in the residuals of the AR1 models (+P,LV $P = 0.514$; +P,HV $P = 0.384$; –P,LV $P = 0.551$; –P,HV $P = 0.918$). The AR1 correction caused slight shifts in the model parameter estimates. However, these estimates were not significantly different from the parameter estimates generated in the simpler models, and did not influence the qualitative outcome of our study (compare Fig. 1 and Fig. S2). Therefore, we report the results from simpler time-series regression models in the paper.

REFERENCES

Ljung .G.M and Box, E.P. 1978. On a Measure of lack of fit in time series models. Biometrika 65: 297-303.

R Development Core Team (2010). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. ISBN 3-900051-07-0, URL http://www.R-project.org.

Table S1. Summary of Ljung-Box tests for time series regression models. +P = intact plant community; –P = plant community removed; LV = low variability precipitation; HV = high variability precipitation.

Treatment	Test Statistic	*P*-value
+P, LV	$\chi^2 = 2.87$	0.090
+P, HV	$\chi^2 = 3.62$	0.057
–P, LV	$\chi^2 = 3.48$	0.230
–P, HV	$\chi^2 = 1.44$	0.062

Table S2. Parameter Estimates (Standard Error) of AR1-corrected time series models

Treatment	Intercept (β_0)	AR1 (ρ)	Moisture (β_1)	Temperature (β_2)	Trend (β_3)
+P,LV	717.5	0.38	27596	93.4	-39.9
	(356.91)	(0.149)	(4800.3)	(27.3)	(8.18)
+P,HV	-1450.2	0.33	14537	123.6	23.1
	(229.62)	(0.174)	(1636.5)	(15.39)	(3.80)
-P,LV	-5963.6	0.37	60156	-16.3	11.0
	(1949.3)	(0.193)	(14013.1)	(22.77)	(11.98)
-P,HV	10381.5	0.22	68013	163.0	-59.7
	(2588.39)	(0.196)	(11159.7)	(82.4)	(28.08)

Figure S1. Data and fits of AR1-corrected CO_2 for the different treatment combinations (+P = intact plant community; –P = plant community removed; LV = low variability precipitation; HV = high variability precipitation).

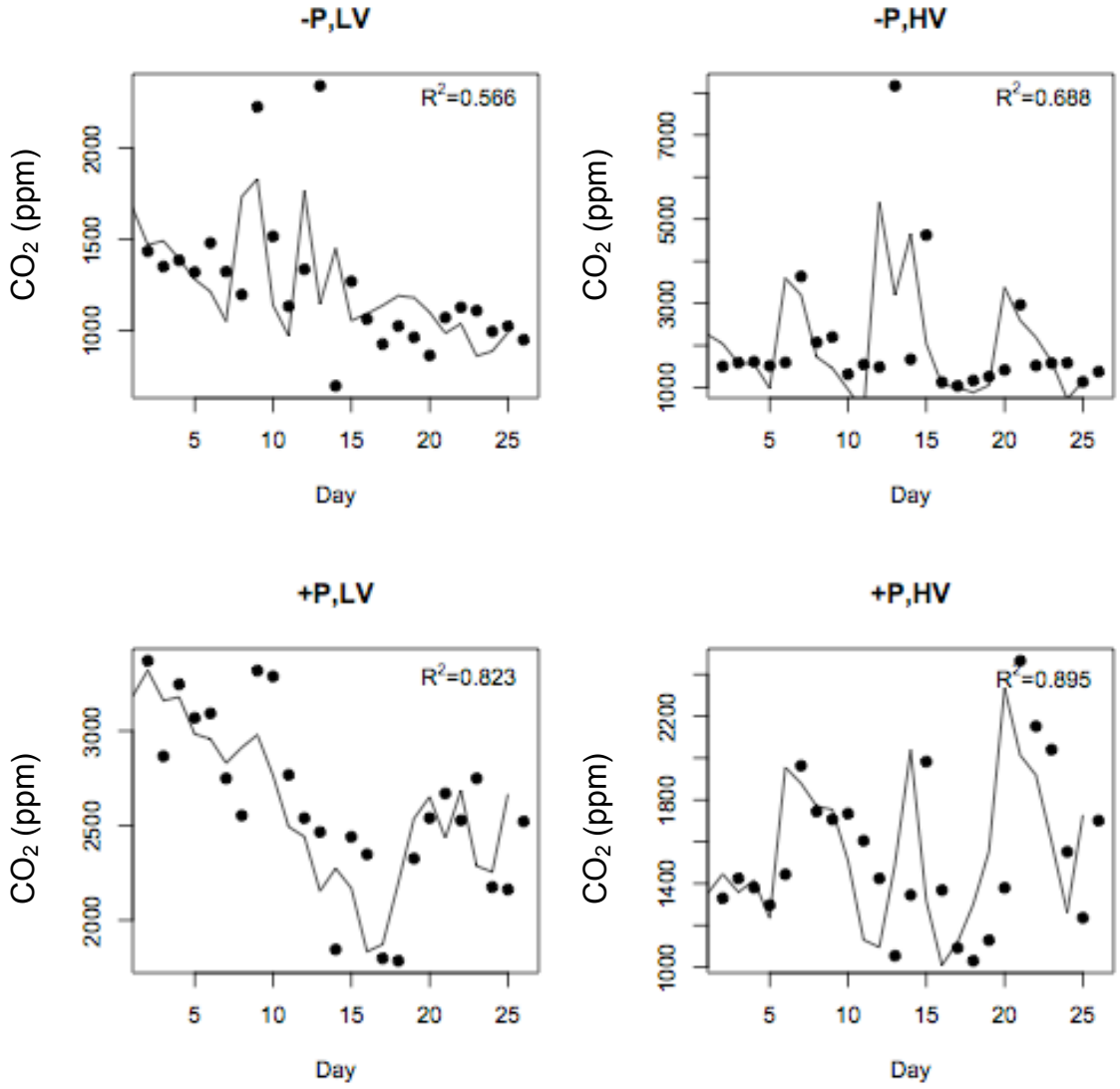
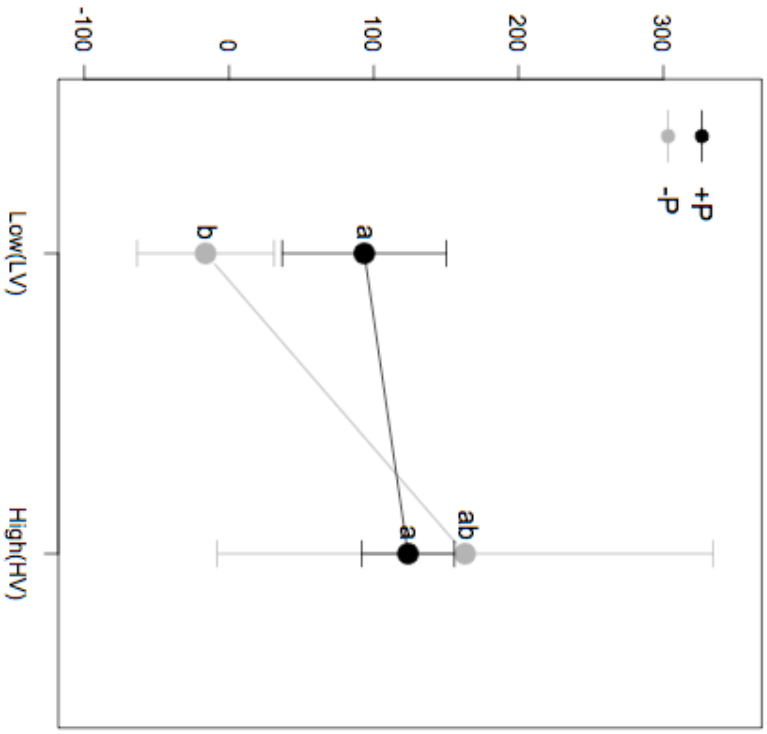


Figure S2. Sensitivity of soil CO_2 to fluctuations in soil moisture (upper panel) and soil temperature (lower panel) under a low variability (LV) and high variability (HV) rainfall treatment in +P and –P soils. All values are parameter estimates from AR1-corrected time-series multiple regression models with attending 95% confidence intervals. Different letters indicate significant differences between treatments (P <0.05) based on pairwise t-tests. Results are qualitatively the same to those presented in Fig. 1.

CO_2 Sensitivity

Temperature

(10^4 moles CO_2 / °C)



Moisture

(10^4 moles CO_2 / m^3 H_2O m^{-3} soil)