

Supplementary Material

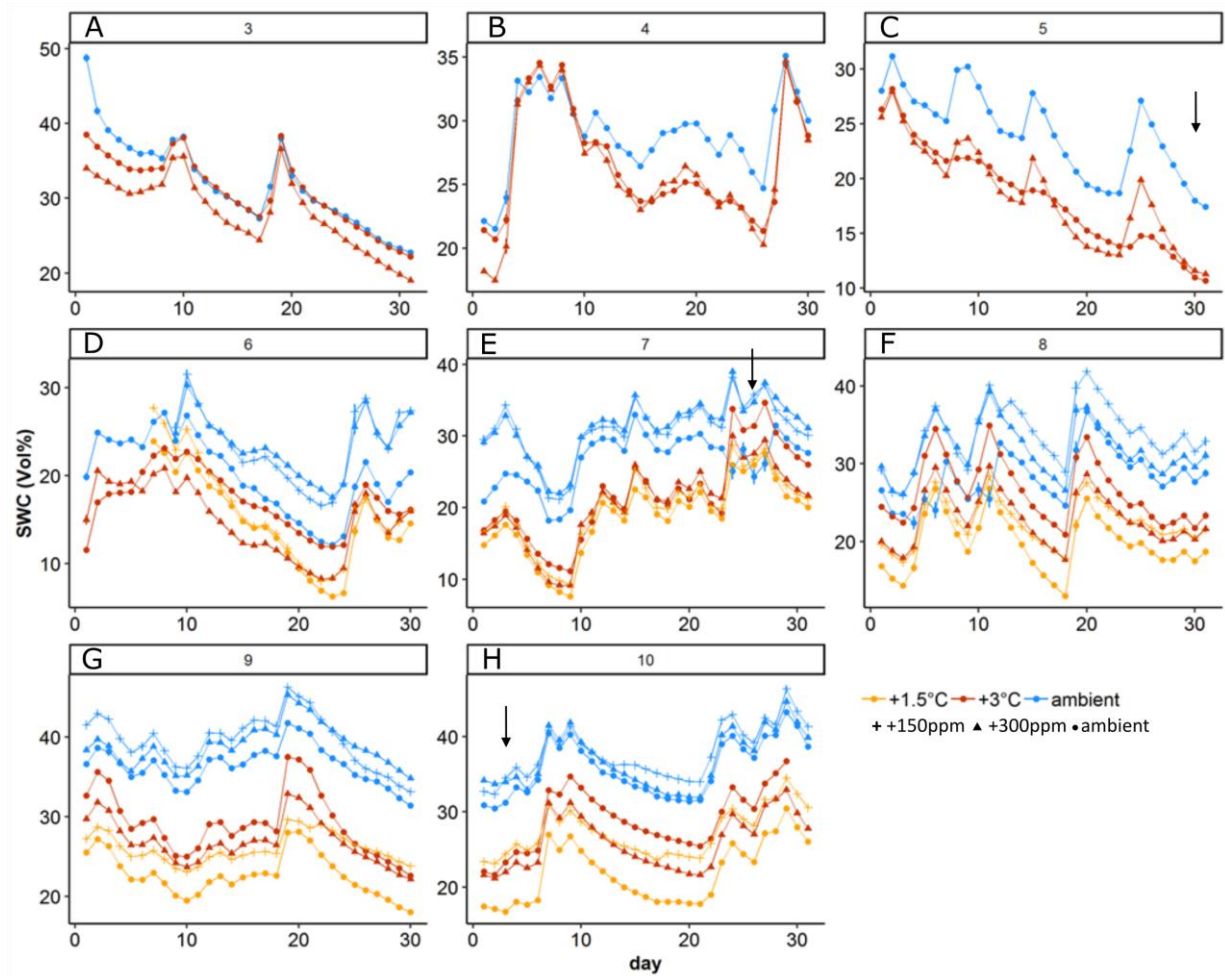


Figure S1 | **Soil water content under single and combined elevated temperature and CO₂ concentration.** Volumetric soil water content (SWC), averaged between 3 and 9 cm depth, in March (A), April (B), May (C), June (D), July (E), August (F), September (G) and October (H) under various combinations of three levels of temperature: ambient (sky blue), 1.5°C above ambient air temperature (orange), 3°C above ambient air temperature (red) and three levels of atmospheric CO₂ concentration: ambient (circular symbols), 150 ppm above ambient (plus symbol), 300 ppm above ambient (triangular symbols). Black arrows indicate sampling time points. Vol% = volumetric %.

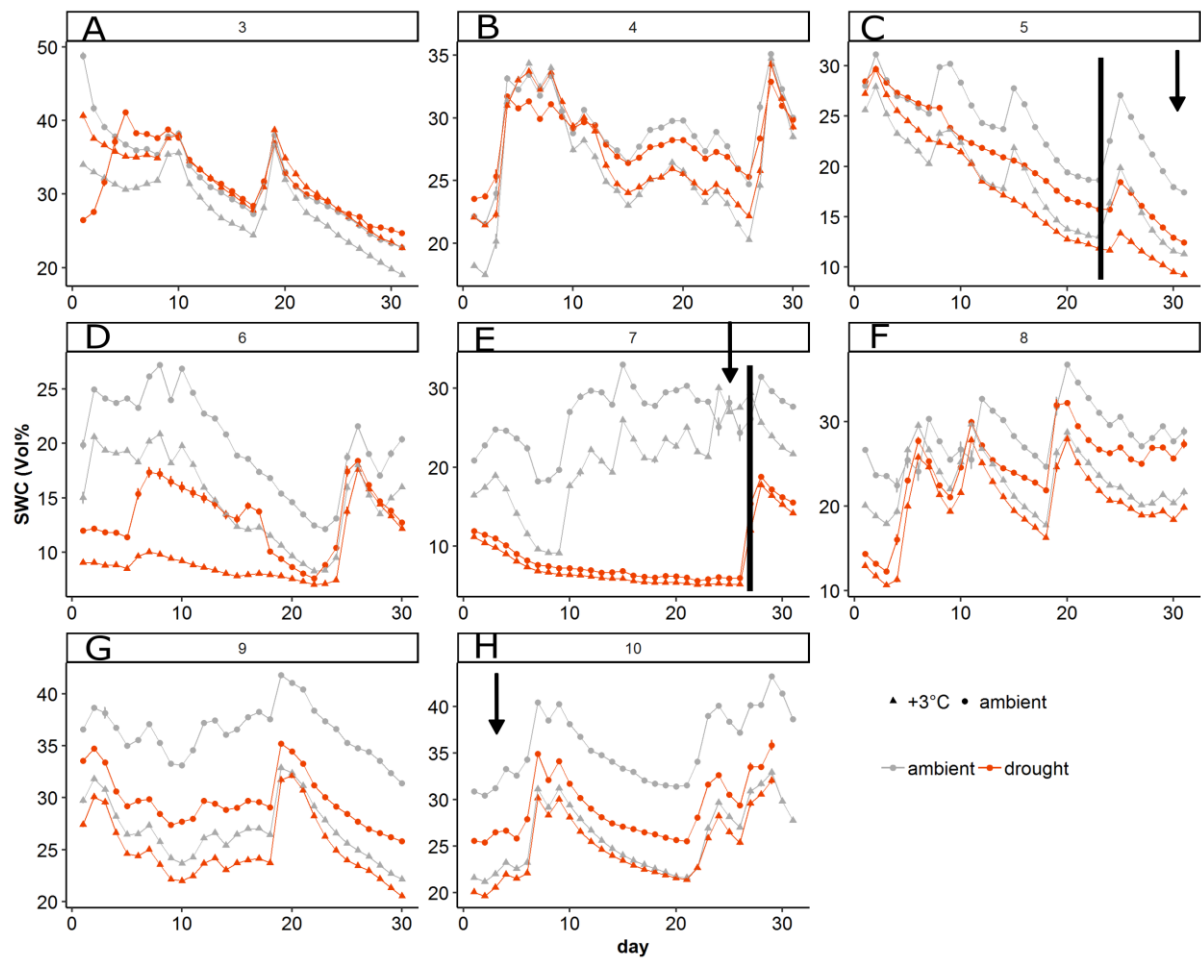


Figure S2 | **Soil water content before -, during drought and after rewetting.** Volumetric soil water content (SWC), averaged between 3 and 9 cm depth, of ambient plots (circular symbols) and future climate plots (triangular symbol, +3 °C, +300 ppm CO₂), which were exposed to drought (red) or were left unmanipulated (grey) in March (A), April (B), May (C), June (D), July (E), August (F), September (G) and October (H). First vertical line represents launch of rain-out shelters, second line indicates rewetting of the drought plots, black arrows indicate sampling time points. Vol% = volumetric %.

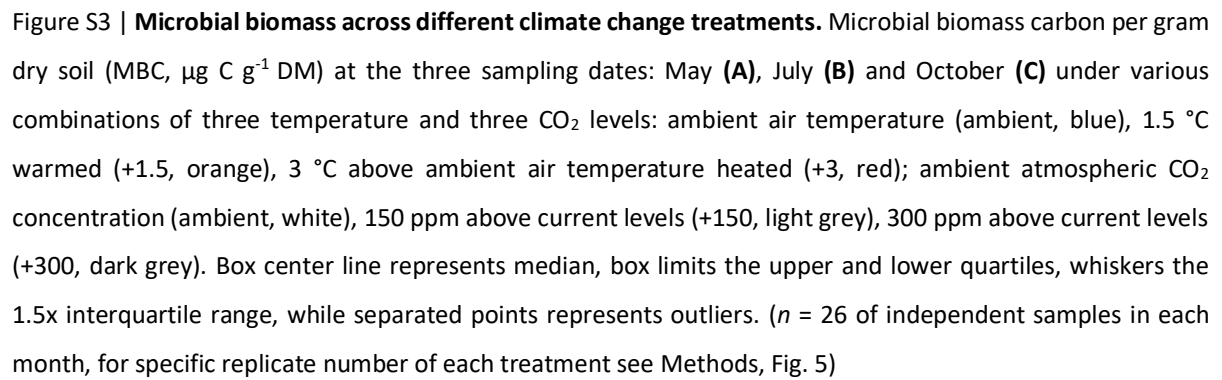


Figure S3 | Microbial biomass across different climate change treatments. Microbial biomass carbon per gram dry soil (MBC, $\mu\text{g C g}^{-1}\text{ DM}$) at the three sampling dates: May **(A)**, July **(B)** and October **(C)** under various combinations of three temperature and three CO₂ levels: ambient air temperature (ambient, blue), 1.5 °C warmed (+1.5, orange), 3 °C above ambient air temperature heated (+3, red); ambient atmospheric CO₂ concentration (ambient, white), 150 ppm above current levels (+150, light grey), 300 ppm above current levels (+300, dark grey). Box center line represents median, box limits the upper and lower quartiles, whiskers the 1.5x interquartile range, while separated points represents outliers. (*n* = 26 of independent samples in each month, for specific replicate number of each treatment see Methods, Fig. 5)

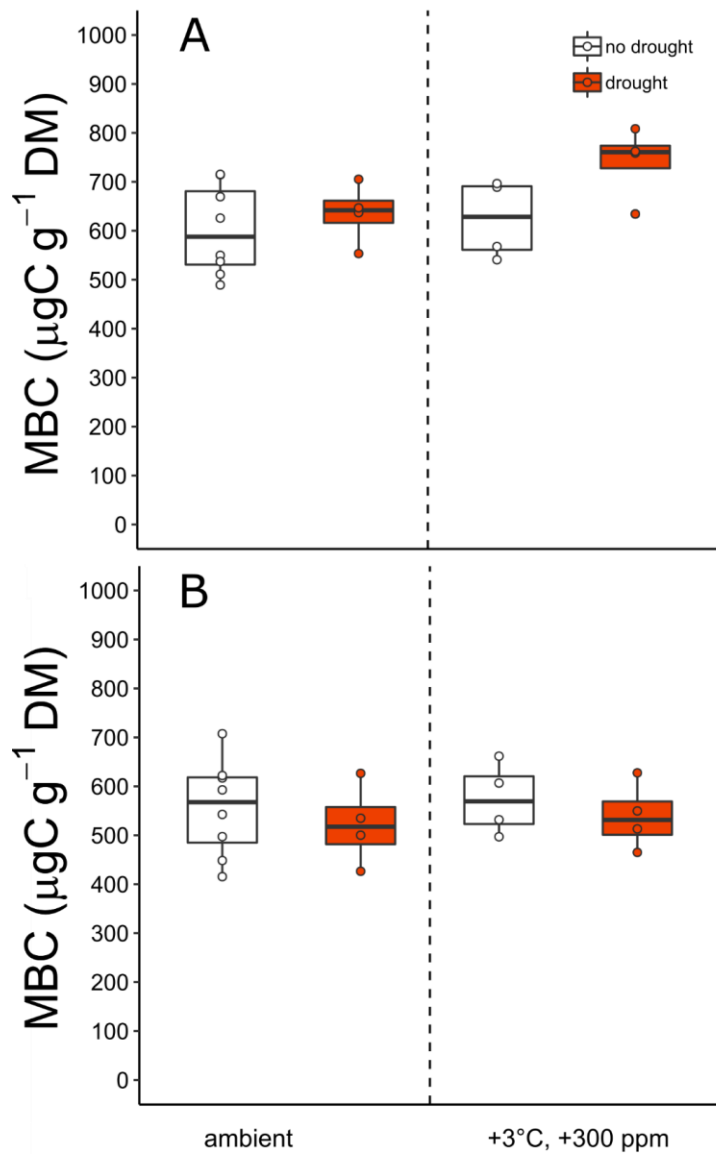


Figure S4 | **Microbial biomass during drought and two months after rewetting.** Microbial biomass carbon (MBC, $\mu\text{g C g}^{-1} \text{ DM}$) in drought (red) and non-drought (white) plots **(A)**, microbial biomass (MBC, $\mu\text{g C g}^{-1} \text{ DM}$) in former drought (red) and in former non-drought (white) plots 2-months after rewetting **(B)**, under ambient and future climate conditions (+3 °C, +300 ppm). DM = dry mass. Box center line represents median, box limits the upper and lower quartiles, whiskers the 1.5x interquartile range, while separated points represents outliers. ($n = 20$ of independent samples in each month, for specific replicate number of each treatment see Methods, Fig. 5)

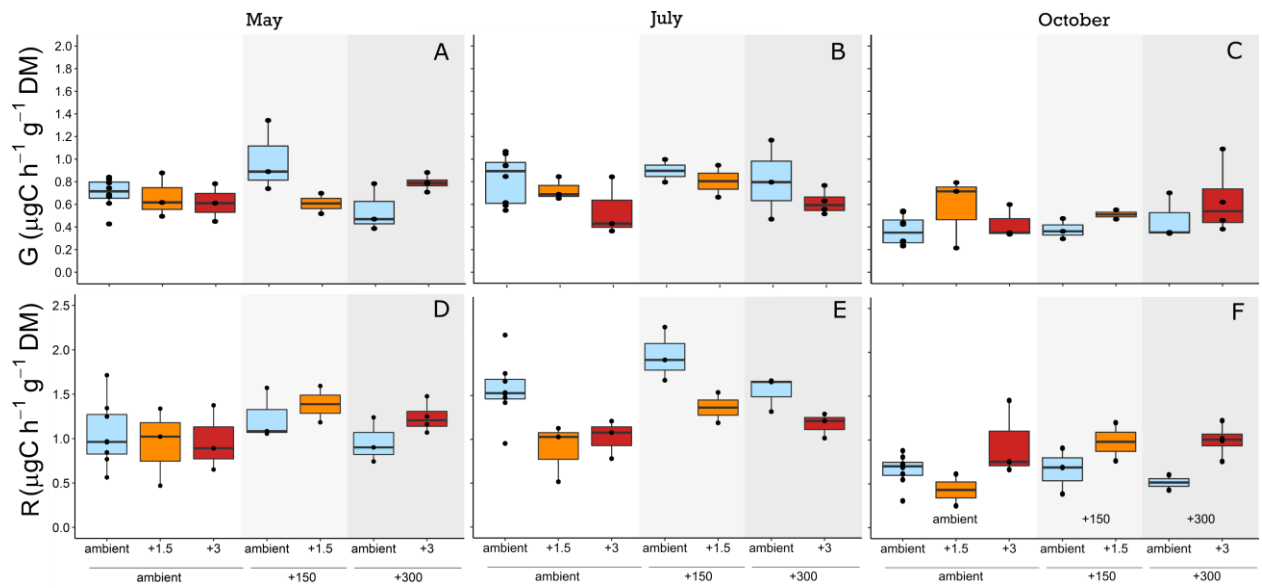


Figure S5 | Response of microbial growth and respiration to single and combined elevated temperatures and CO₂ concentrations. Growth per gram soil (G, $\mu\text{g C h}^{-1} \text{g}^{-1} \text{DM}$) in May (A), July (B) and October (C) and respiration per gram soil (R, $\mu\text{g C h}^{-1} \text{g}^{-1} \text{DM}$) in May (D), July (E) and October (F) under various combinations of three temperature - and three CO₂ levels: ambient air temperature (ambient, blue), 1.5 °C warmed (+1.5, orange), 3 °C above ambient air temperature (+3, red); ambient atmospheric CO₂ concentration (ambient, white), 150 ppm CO₂ above ambient levels (+150, light grey), additional 300 ppm CO₂ (+300, dark grey). DM = dry mass. Box center line represents median, box limits the upper and lower quartiles, whiskers the 1.5x interquartile range, while separated points represent outliers. ($n = 26$ of independent samples in each month, for specific replicate number of each treatment see Methods, Fig. 5)

Supplementary Tables

Table S1 | **Number of replicates (replicated plots in the surface response design) of the nine selected treatments and identification of treatments used in the two different statistical models tested.**

Treatment	Number of plots	Response surface model	Anova model
ambient climate	8	Yes	Yes
ambient CO ₂ , +1.5°C	3	Yes	No
ambient CO ₂ , +3°C	3	Yes	No
+150 ppm, ambient temperature	3	Yes	No
+150 ppm, +1.5°C	2	Yes	No
+300 ppm, ambient temperature	3	Yes	No
future climate (+300 ppm, +3°C)	4	Yes	Yes
ambient climate + drought	4	No	Yes
future climate + drought	4	No	Yes

Table S2 | **Incubation temperatures according to field temperature treatments.**

Temperature treatment	May	July	October
ambient	16	17	13
+1.5 °C	17.5	18.5	14.5
+3 °C	19	20	16

Incubation temperatures were set according to mean field temperatures of the three temperature treatments in May, July and October 2017.

Table S3 | Effects of climate change treatments on microbial biomass carbon (per unit of soil mass) throughout the vegetation period.

MBC	May				July				October			
	Est.	SE	t	p	Est.	SE	t	p	Est.	SE	t	p
eCO ₂	-27.20	23.36	-1.16	0.2561	-3.07	22.16	-0.13	0.8909	17.16	18.43	0.93	0.3623
eT	6.51	23.60	0.27	0.7853	3.02	22.39	0.13	0.8938	-7.56	18.35	-0.41	0.6843
eCO ₂ :eT												
eCO ₂ ²												
eT ²												

Significances of elevated atmospheric CO₂ level (eCO₂) and increased air temperature (eT) as predictors of microbial biomass carbon (MBC, µgC g⁻¹ DM) at each sampling time point (May, July and October). Values are derived from RSM models. eCO₂² & eT² – quadratic function of elevated CO₂ and temperature, eCO₂:T interaction of elevated CO₂ concentration and temperature. Est. = Estimated slope, SE = Standard error.

Table S4 | Microbial biomass carbon (per unit of soil mass) during drought and two months after rewetting.

	df	SS	MS	F	p
MBC					
Drought					
eCO ₂ + eT	1	23076	23075.6	3.47	0.081
drought	1	22730	22729.6	3.42	0.0831
(eCO ₂ + eT): drought	1	7942	7942.5	1.19	0.2907
Rewetting					
eCO ₂ + eT	1	725	724.8	0.09	0.7586
drought	1	5479	5479.5	0.74	0.4026
(eCO ₂ + eT): drought	1	5	4.9	0.0007	0.9799

Statistical significances of drought (drought) and climate change treatment (eCO₂ + eT), respectively significances of legacy effect of former drought plots (drought) and future climate plots (eCO₂ + eT) as explanatory variables of microbial biomass carbon (MBC, µgC g⁻¹ DM) 2-months after rewetting. MBC = microbial biomass carbon, eCO₂ = elevated CO₂, et = elevated temperature. Values are derived from a two-way ANOVA. (eCO₂ + eT): drought interaction between climate treatment and drought. df = degree of freedom, SS = Sum of Squares, MS = Mean Squares.

Table S5 | Effects of treatment and seasonality on microbial growth and respiration.

	May				July				October			
G	Est.	SE	t	p	Est.	SE	t	p	Est.	SE	t	p
eCO ₂	0.29	0.26	1.11	0.2798	0.01	0.05	0.28	0.7803	0.05	0.05	1.08	0.2896
eT	-0.35	0.22	-1.61	0.1237	-0.12	0.05	-2.565	0.01804	0.08	0.05	1.71	0.1011
eCO ₂ :eT	0.07	0.05	1.39	0.179								
eCO ₂ ²	-0.18	0.14	-1.33	0.1983								
eT ²	0.16	0.11	1.36	0.189								
R												
eCO ₂	0.07	0.07	0.94	0.3573	0.08	0.39	1.95	0.6652	0.02	0.05	0.36	0.7222
eT	0.03	0.07	0.43	0.666	-1.07	0.33	-3.27	0.0041	0.14	0.05	2.66	0.0149
eCO ₂ :eT					0.04	0.08	0.53	0.5987				
eCO ₂ ²					-0.38	0.20	-1.87	0.0764				
eT ²					0.40	0.17	2.34	0.0309				

Statistical significances of the effect of (combined) elevated CO₂ level (eCO₂) and increased temperature (eT) on growth rate per gram soil (G, µgC h⁻¹ g⁻¹ DM) and respiration rate per gram soil (R, µgC h⁻¹ g⁻¹ DM). Values are derived from RSM models. eCO₂² & eT² quadratic functions, “:” indicate interaction of two or three predictors. Est. = Estimated slope, SE = Standard error, p-value < 0.05 are given in bold.

Table S6 | Relevance of seasonality for growth and respiration.

	G			R		
	df	F	p	df	F	p
date	1	21.95	<0.0001	1	12.93	0.0006
eCO ₂	1	0.87	0.3549	1	3.58	0.0626
eT	1	0.03	0.8561	1	0.03	0.8688
eCO ₂ ²						
eT ²						
date:eCO ₂	1	1.07	0.3041	1	0.35	0.5551
date:eT	1	1.51	0.2239	1	0.17	0.6827
eCO ₂ :eT	1	1.30	0.2585	1	0.80	0.3756
date:eCO ₂ :eT	1	0.58	0.4471	1	0.26	0.6119

Statistical significances of the effect of seasonality (date), elevated CO₂ level (eCO₂) and increased temperature (eT) on growth rate per gram soil (G, µgC h⁻¹ g⁻¹ DM) and respiration rate per gram soil (R, µgC h⁻¹ g⁻¹ DM), derived from GLS models. eCO₂² & eT² – quadratic functions, “:” indicate interaction of two or three predictors. df = degree of freedom, statistically significant values are given in bold (if p-value < 0.05).