



Supplement of

Temperature sensitivity of soil organic carbon respiration along a forested elevation gradient in the Rwenzori Mountains, Uganda

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1 **Supplementary information**

2 Table S1. Pearson correlations of CO₂ respiration rate with soil parameters along the Rwenzori elevational gradient
3 under *in situ* and laboratory incubation.

Total CO ₂ respiration rate at the start of the rainy season		
Soil parameter	Correlation R value	<i>P</i> -value
pH	0.13	0.19
Water-filled pore space	-0.04	0.73
Temperature	0.24	0.02*
Organic carbon	-0.19	0.06
Total nitrogen	-0.29	<0.01*
C:N	0.17	0.09
Total CO ₂ respiration rate in the mid rainy season		
pH	0.56	<0.01*
Water-filled pore space	0.25	0.01*
Temperature	0.55	<0.01*
Organic carbon	-0.61	<0.01*
Total nitrogen	-0.59	<0.01*
C:N	-0.40	<0.01*
Specific heterotrophic CO ₂ respiration rate from laboratory incubation		
pH	0.79	<0.01*
Temperature	0.73	<0.01*
Organic carbon	-0.73	<0.01*
Total nitrogen	-0.75	<0.01*
C:N	-0.69	<0.01*

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5 A significant *P*-value is marked with an asterisk symbol “*”

6 Table S2. The scores of the principle component analysis with correlations for principle component 1 (PC1) and
7 principle component 2 (PC2). Strong correlation scores above 0.5 by magnitude are shown in bold.

Parameter	PC1 correlation score	PC2 correlation score
Total PLFA (bacteria plus fungi)	-0.85	-0.67
Fungi	-0.88	-0.63
Gram-positive bacteria	-0.82	-0.70
Gram-negative bacteria	-0.66	-0.89
Bacteria : Fungi	0.39	-0.13
Gram-positive : Gram-negative	-0.22	0.73
Soil pH _{KCl}	0.92	-0.58
Soil organic carbon	-1.0	0.26
Soil temperature	1.0	-0.34
Soil total nitrogen	-1.00	0.25
Soil C:N	-0.90	0.34
Bulk density	0.98	-0.37

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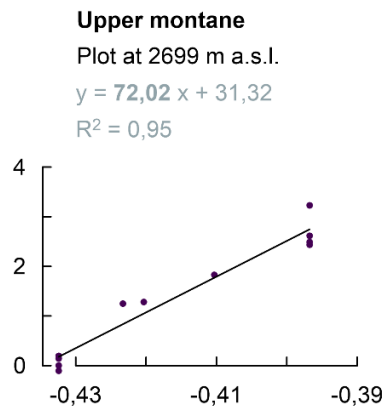
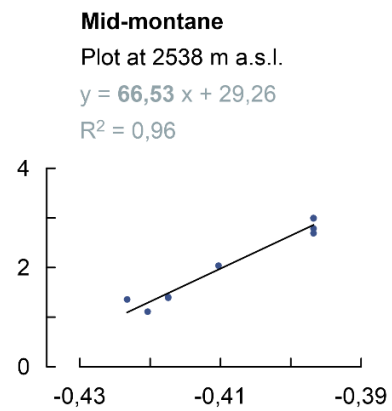
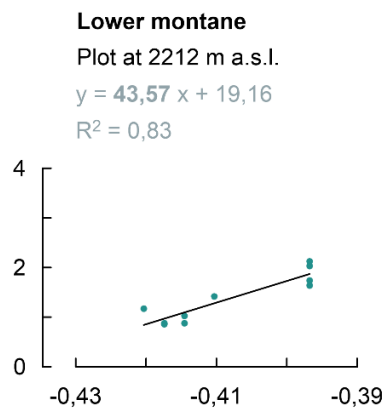
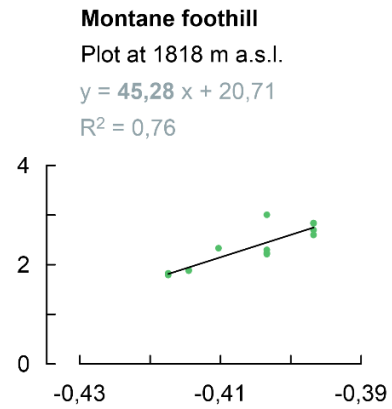
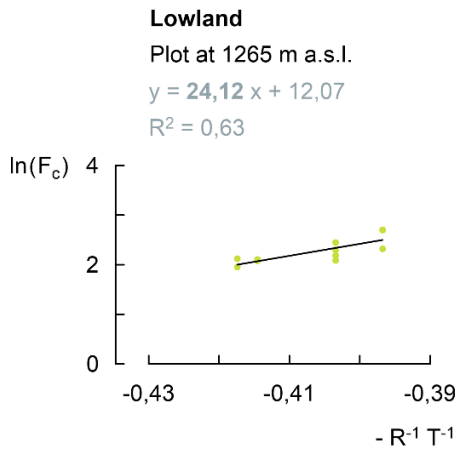
Table S3. Comparison of the *in situ* seasonal soil moisture content at the start and in the mid rainy season, the *in situ* soil temperature at the start and in the mid rainy season, the *in situ* total CO₂ respiration rate at the start and in the mid rainy season, the specific heterotrophic CO₂ respiration rate for control and warmed soil at corresponding field temperature, the specific heterotrophic CO₂ respiration rate for control and warmed soil at uniform reference temperature of 20 °C and 12 °C, the temperature sensitivity Q₁₀, and the activation energy at each elevation cluster in the Rwenzori elevational gradient.

Elevation (m a.s.l.)	Parameter		P value
	<i>In situ</i> WFPS at the start of rainy season (%)	<i>In situ</i> WFPS in the mid rainy season (%)	
1250-1300	33.1 ± 1.2 ^b	57.2 ± 5.8 ^a	<0.01
1750-1850	22.2 ± 2.5 ^c	44.8 ± 3.8 ^b	<0.01
2100-2200	41.7 ± 2.9 ^a	45.4 ± 4.8 ^b	<0.01
2700-3000	42.7 ± 8.7 ^a	44.5 ± 9.0 ^b	0.48
	<i>In situ</i> temperature at the start of rainy season (°C)	<i>In situ</i> temperature in the mid rainy season (°C)	
1250-1300	19.56 ± 0.32 ^a	20.44 ± 0.41 ^a	<0.01
1750-1850	16.16 ± 0.43 ^b	16.76 ± 0.23 ^b	<0.01
2100-2200	15.02 ± 0.12 ^c	16.04 ± 0.68 ^c	<0.01
2700-3000	11.86 ± 0.46 ^d	12.32 ± 0.39 ^d	<0.01
	<i>In situ</i> total CO ₂ respiration rate at the start of rainy season (mg C h ⁻¹ m ⁻²)	<i>In situ</i> total CO ₂ respiration rate in the mid rainy season (mg C h ⁻¹ m ⁻²)	
1250-1300	80.1 ± 15.8 ^a	113.2 ± 35.7 ^a	<0.01
1750-1850	79.2 ± 17.3 ^a	112.8 ± 20.3 ^a	<0.01
2100-2200	95.1 ± 34.6 ^a	89.0 ± 22.3 ^b	0.46
2700-3000	59.3 ± 16.7 ^b	67.7 ± 9.7 ^c	0.05
	Specific heterotrophic CO ₂ respiration rate at respective field mean annual temperature (µg C h ⁻¹ g ⁻¹ SOC)	¹³ C isotopic fractionation during heterotrophic CO ₂ respiration (epsilon)	
1250-1300	17.2 ± 5.3	-3.2 ± 0.6	NA
1750-1850	10.8 ± 4.8	-2.8 ± 0.9	NA
2100-2200	5.3 ± 2.1	-1.7 ± 0.7	NA
2500-2600	3.7 ± 1.9	-1.0 ± 1.3	NA
2700-3000	2.4 ± 0.9	0.3 ± 0.8	NA
	Specific heterotrophic CO ₂ respiration rate following <i>in situ</i> soil warming at corresponding field temperature (µg C h ⁻¹ g ⁻¹ SOC)		

	Control	Warmed	
1250-1300	6.15± 0.28	NA	NA
1750-1850	6.56± 0.61	5.48 ± 1.69	0.10
2100-2200	3.22 ± 0.25	3.31 ± 1.17	0.70
2500-2600	3.54 ± 0.53	3.92 ± 1.40	0.06
2700-3000	3.82 ± 0.45	2.74 ± 0.85	0.13
Activation energy (kJ mol ⁻¹)			
	Control	Warmed	
1250-1300	28.5 ± 5.6	NA	NA
1750-1850	49.2± 17.3	30.3 ± 11.0	0.23
2100-2200	60.2 ± 23.1	53.6 ± 9.7	1.00
2500-2600	70.3 ± 6.9	59.8 ± 4.2	0.06
2700-3000	69.9 ± 3.0	73.9 ± 20.7	0.80
The sensitivity of CO ₂ respiration to temperature (Q ₁₀)			
	Control	Warmed	
1250-1300	1.50 ± 0.13	NA	NA
1750-1850	1.92± 0.57	1.70 ± 0.24	0.86
2100-2200	2.67 ± 1.28	2.14± 0.44	1.00
2500-2600	2.86 ± 0.40	2.52 ± 0.47	0.20
2700-3000	2.68 ± 0.25	2.46 ± 0.67	0.53
Soil organic carbon (%)			
1750-1850	7.42 ± 1.03	5.89 ± 2.10	0.343
2100-2200	13.63 ± 0.52	15.62± 4.07	1.00
2500-2600	28.01 ± 3.51	23.11 ± 6.01	0.229
2700-3000	31.72 ± 2.10	28.65 ± 9.11	0.48
Soil δ ¹³ C (‰)			
1750-1850	-26.37 ± 1.10	-24.79 ± 0.89	0.057
2100-2200	-26.30 ± 0.69	-26.70 ± 0.78	0.486
2500-2600	-29.70 ± 0.42	-28.07 ± 0.72	0.057
2700-3000	-28.88 ± 0.39	-28.58± 1.27	0.686
Soil δ ¹⁵ N (‰)			
1750-1850	6.74 ± 0.41	7.65 ± 0.76	0.200
2100-2200	5.76 ± 0.42	5.47 ± 1.26	0.886
2500-2600	1.46 ± 0.61	2.61 ± 1.44	0.229
2700-3000	1.15 ± 0.47	2.08 ± 0.90	0.200

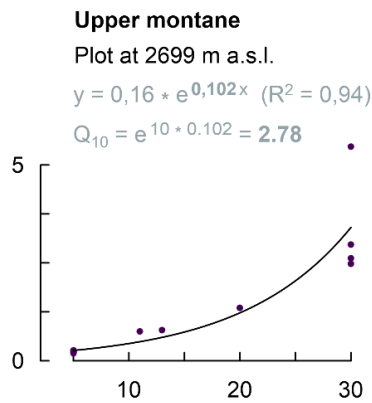
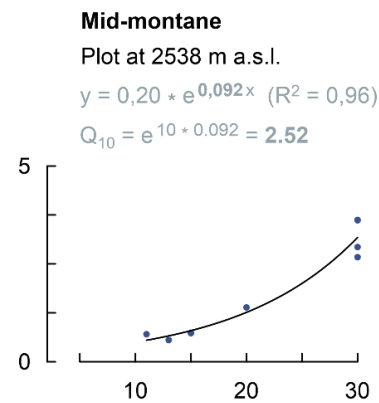
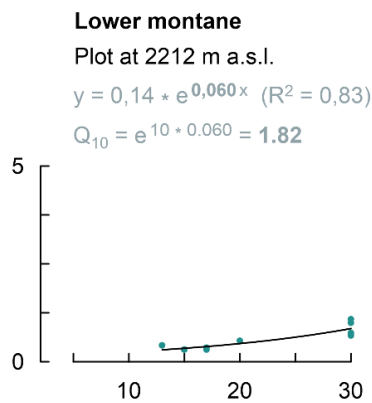
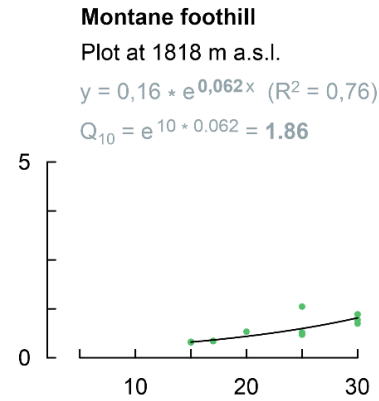
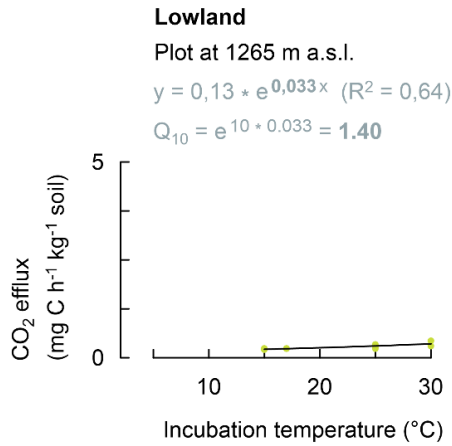
16 *NA indicate that no comparison between control and warmed soil was made because no translocation took place
17 at elevation cluster 1250-1300 m a.s.l.. Different lowercase letters in superscript (bold) next to values of each

18 elevation cluster (same column) indicate a significant difference among the sites at $P < 0.05$, and $P < 0.05$ (same
19 row) indicates a significant different between seasons or between control and warmed treatments.



20

21 Figure S1. Graphs to illustrate the curve fitting for the determination of the activation energy, i.e., as the slope of
 22 the linear regression between log-transformed specific heterotrophic CO₂ respiration rate ($\ln F_c$) and the negative
 23 inverse of the incubation temperature (T), multiplied with the gas constant (R). Shown here is one representative
 24 example (one replicate per plot) per elevation cluster.



25
26 Figure S2. Graphs to illustrate the curve fitting for the determination of the sensitivity of heterotrophic CO₂
27 respiration rates to temperature (Q_{10}) through exponential curve fitting of specific heterotrophic CO₂ respiration
28 rates at five different incubation temperatures in order to derive parameter k, from which Q_{10} can be determined.
29 Shown here is one representative example (i.e. one replicate plot) per elevation cluster.

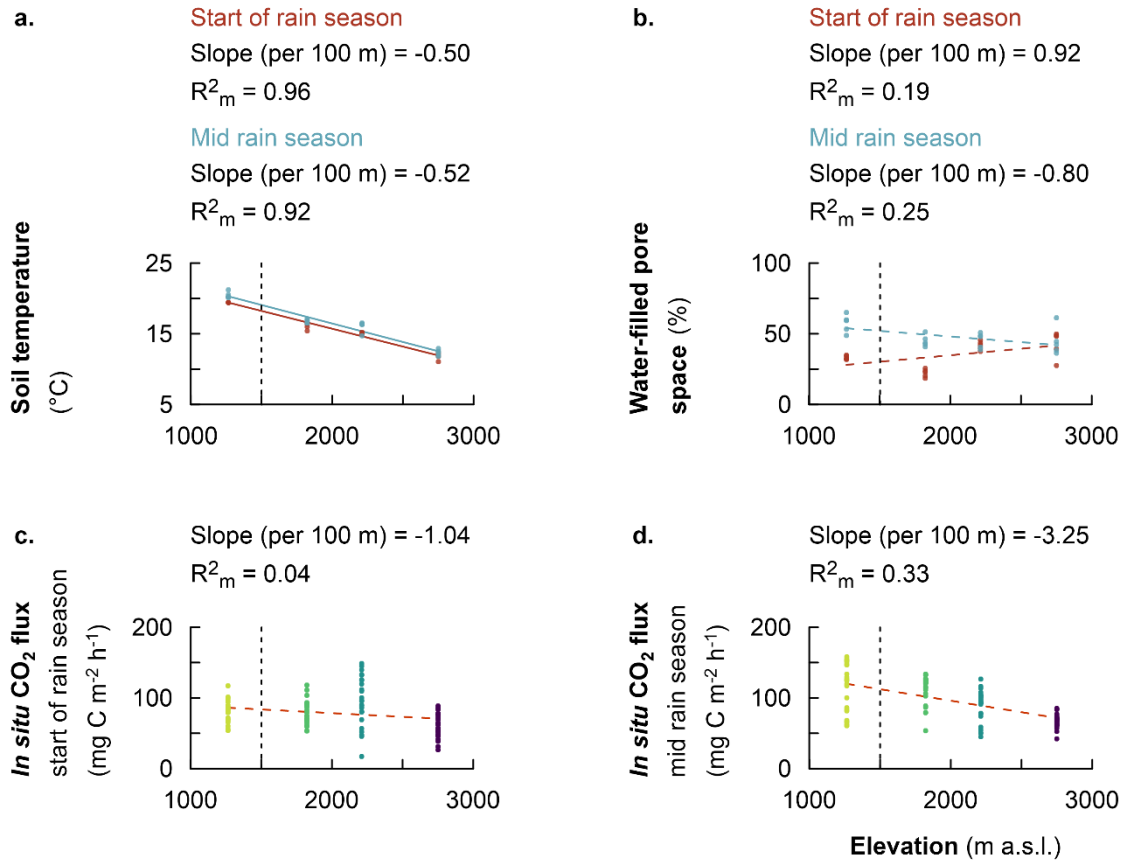


Figure S3. Fixed effect estimates of elevation (per 100 m elevation increase) on response variables: soil temperatures at 5 cm depth at the start of rainy season (red solid line) and in the mid rainy season (blue solid line) (a), water-filled pore space at 5 cm depth at the start of the rainy season (red dashed line) and in the mid rainy season (blue dashed line) (b), *in situ* total CO₂ respiration at the start of the rainy season (c) and *in situ* total CO₂ respiration in the mid rainy season (d). The slope of the linear mixed effect model estimates per 100 m of elevation increase is indicated (solid line for a significant effect and dashed line for no significant effect), as well as the marginal R^2 (R^2_m), representing the fraction in response variable explained by elevation. Plots from montane forest clusters (from 1750-3000 m a.s.l.) were compared with a nearby premontane forest (separated by vertical dashed line) at an elevation of 1250-1300 m a.s.l..

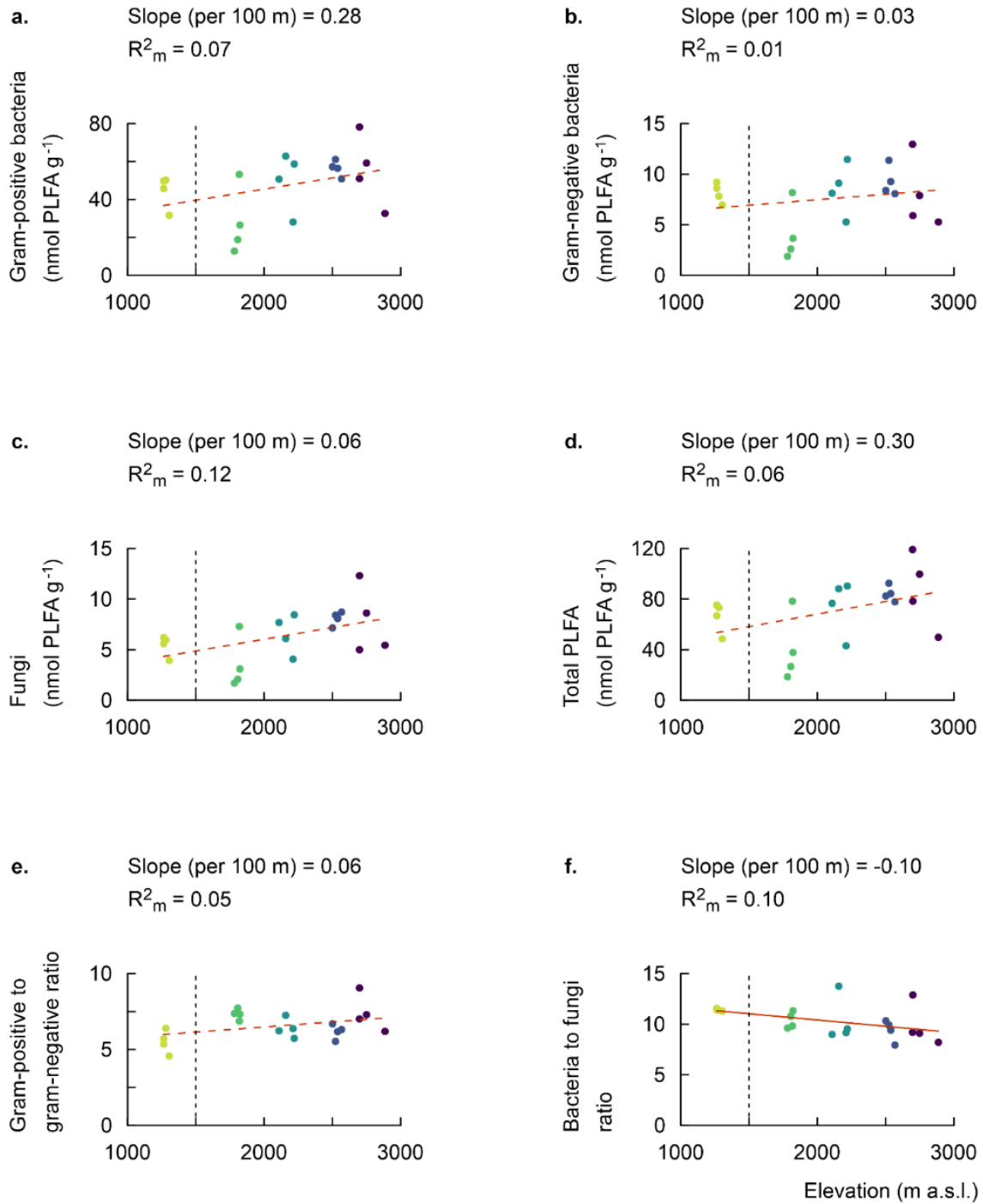


Figure S4. Fixed effect estimates of elevation (per 100 m elevation increase) on response variables: gram-positive bacteria (nmol PLFA g⁻¹) (a), gram-negative bacteria (nmol PLFA g⁻¹) (b), fungi (nmol PLFA g⁻¹) (c), total phospholipid fatty acids (PLFA) for bacteria and fungi (d) (nmol PLFA g⁻¹), ratio of gram-positive to gram-negative bacteria (e) and the ratio of bacteria to fungi (f). The slopes of the linear mixed effect model estimates per 100 m of elevation increase are indicated (red solid line for a significant effect and red dashed line for no significant effect), as well as the marginal R^2 (R^2_m), representing the fraction in response variable explained by elevation. Plots from montane forest clusters (from 1750-3000 m a.s.l.) were compared with a nearby premontane forest (separated by vertical dashed line) at an elevation of 1250-1300 m a.s.l..

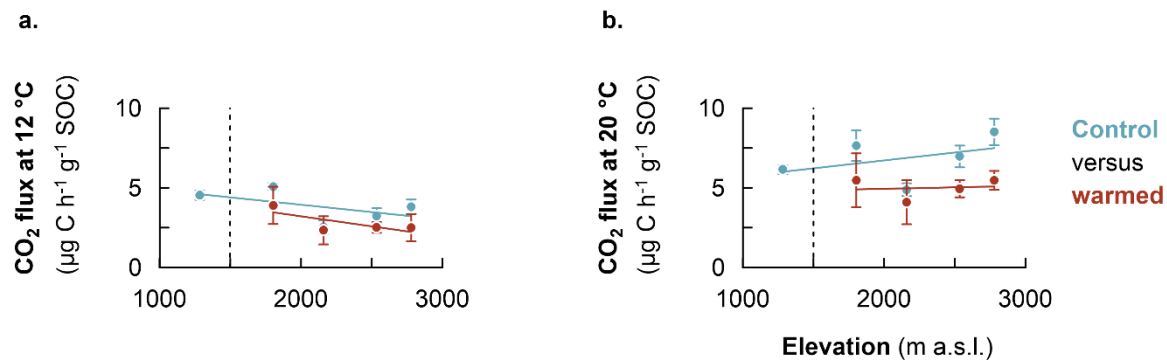


Figure S5. Specific heterotrophic CO₂ respiration rate at uniform reference temperature of 20 °C (mean annual *in situ* temperature in the lowest elevation cluster at 1250-1300 m a.s.l.) (a) and 12 °C (mean annual *in situ* temperature in the highest elevation cluster at 2700-3000 m a.s.l.) (b).