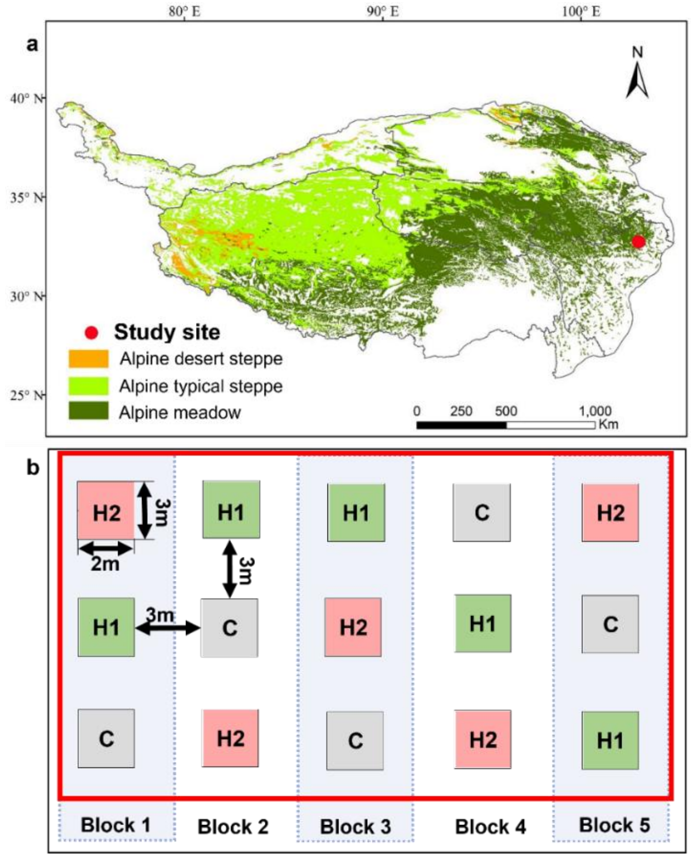
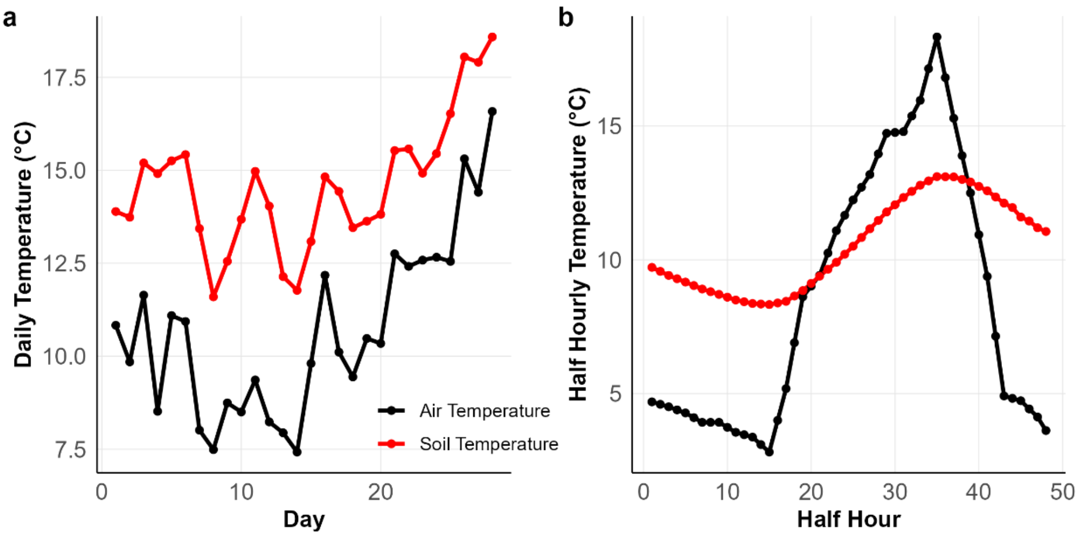
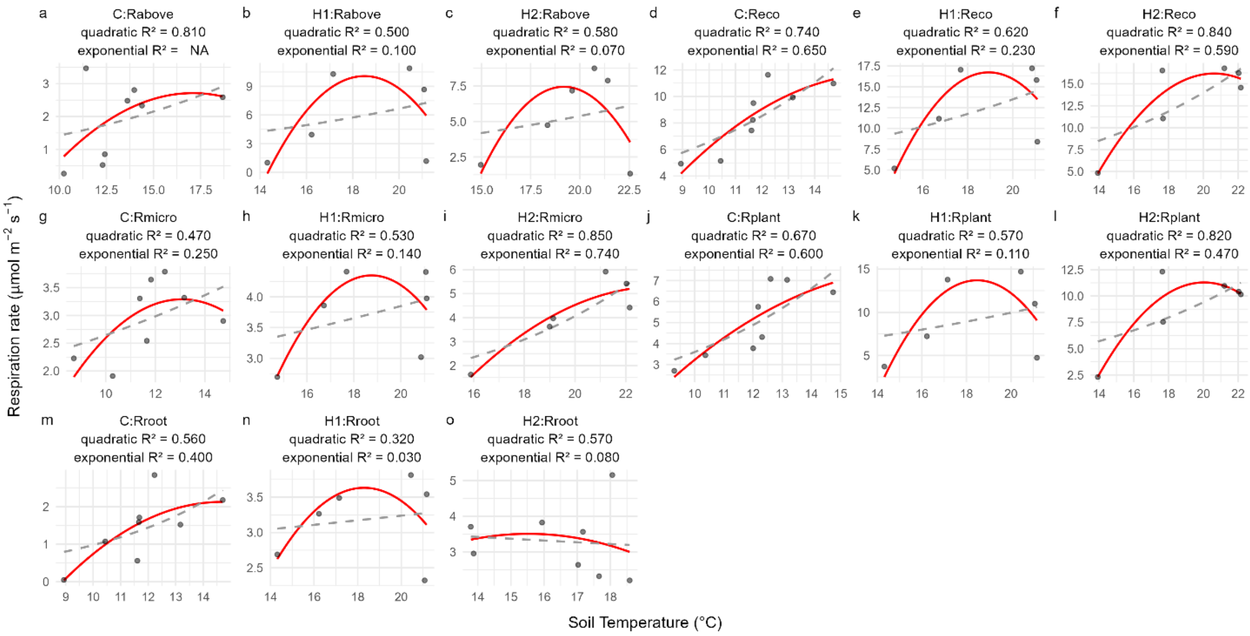
Supplementary data



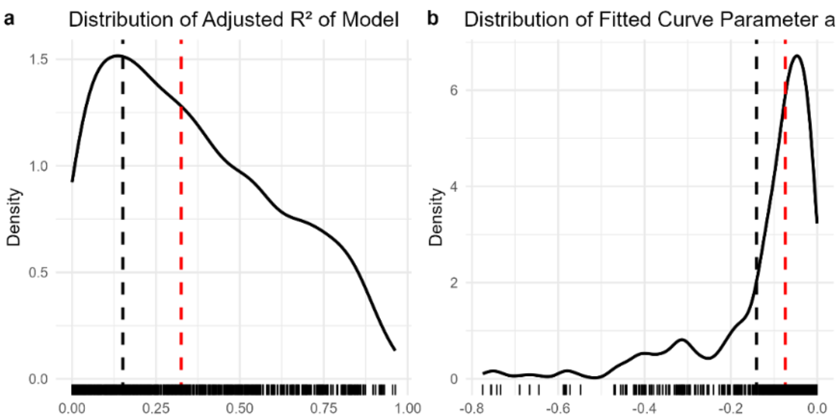
Supplementary Figure 1 Study site and experiment design. (a) Geographic location of the study site. (b) Schematic illustration of the warming experiment design.



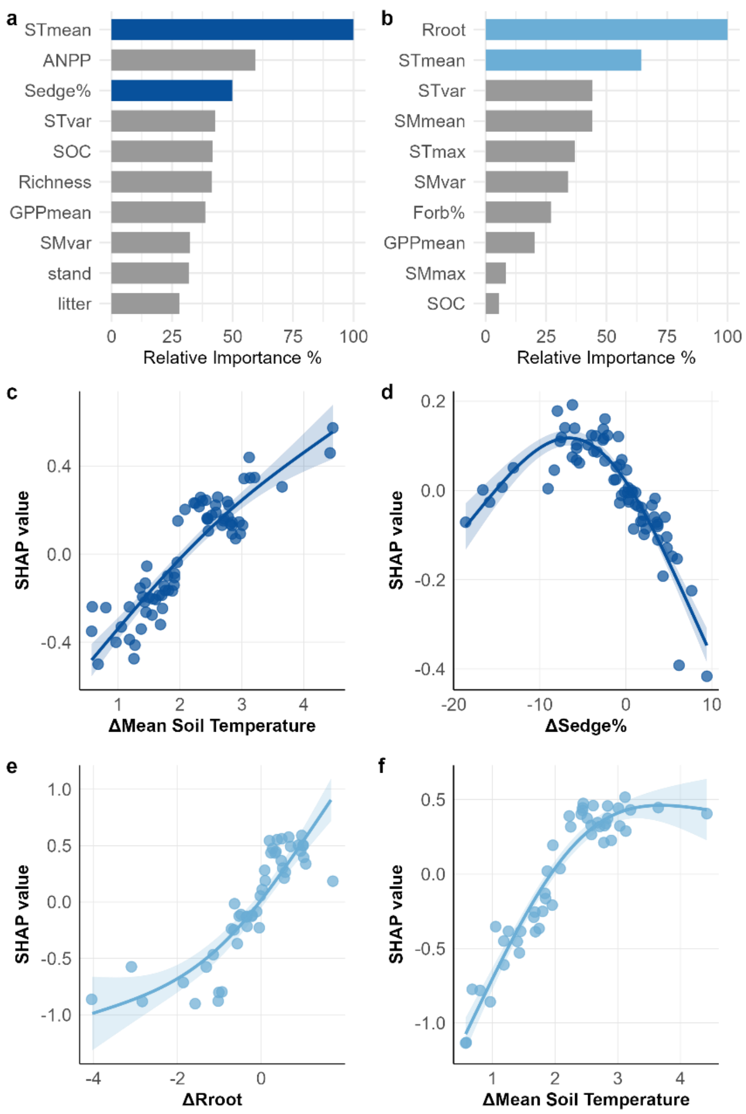
Supplementary Figure 2 Comparison of soil temperature and air temperature time series at (a) daily and (b) half-hourly scales. Data were obtained from the meteorological tower. Red points and lines represent soil temperature, and black points and lines represent air temperature.



Supplementary Figure 3 Response curves of respiration components to soil temperature under warming treatments. The red curve represents the fit of the quadratic model, while the gray dashed curve represents the fit of the exponential model.



Supplementary Figure 4 Distribution density of the Goodness-of-fit and key parameter of fitted quadratic model at the sites with optimal temperature (T_{opt}) for all respiration component (R_i). The black and red dashed lines are the median and mean respectively.



Supplementary Figure 5 Comparison and drivers of thermal acclimation magnitude between aboveground (R_{above}) and root (R_{root}) respiration components. (a) Differences in the degree of thermal acclimation in T_{opt} between R_{above} and R_{root}. (b-c) Relative importance of environmental and biological variables influencing the thermal acclimation of (b) T_{opt} of R_{above} and (c) T_{opt} of R_{root}. (d-e) SHAP value responses of significant predictors for R_{above} acclimation. (f-g) SHAP value responses of significant predictors for R_{root} acclimtion. Dark and light blue bars indicate significant effects for R_{above} and R_{root}, respectively; gray bars denote non-significant effects. Statistical significance is denoted as ns ($p > 0.05$), * ($p \leq 0.05$), ** ($p < 0.01$), and *** ($p < 0.001$). Relative importance (%) was calculated based on the percentage increase in mean squared error (IncMSE%), with the highest IncMSE% scaled to 100%. Δ represents the difference in environmental variables between warming and control treatments.

Supplementary Table 1 Summary of previous studies on the T_{opt} of different components of ecosystem respiration.

Respiration components	T_{opt}	References

Plant leaf	51.0-60.6℃	(O'sullivan et al., 2017)
	48℃	(Heskel et al., 2014)
	51-57℃	(O'Sullivan et al., 2013)
	52.2-55.0℃	(Aspinwall et al., 2019)
	52.4-59.8℃	(Gauthier et al., 2014)
	55.0-61℃	(Zhu et al., 2021)
Plant root	40℃	(Palta & Nobel, 1989)
	30-40℃	(Chen et al., 2000)
	40℃	(Covey-Crump et al., 2002)
Soil microbe	32.9℃	(Alster et al., 2023)
	35℃	(Schipper et al., 2014)
	38.5-46.0℃	(Liu et al., 2018)
	35-40℃	(Pietikäinen et al., 2005)
	36℃	(Balser & Wixon, 2009)

Supplementary Table 2 The environmental factors and abbreviations used in Random Forest analysis.

Category	Indicator	Abbreviation
Heat	Maximum soil temperature	ST_{max}
	Averaged soil temperature	ST_{mean}
	Minimum soil temperature	ST_{min}
	Variation of soil temperature	ST_{var}
Water	Averaged soil moisture	SM_{mean}
	Minimum soil moisture	SM_{min}
	Maximum soil moisture	SM_{max}
	Variation of soil moisture	SM_{var}
Production	Averaged gross primary product	GPP_{mean}
	Maximum gross primary product	GPP_{max}
	Plant litter	litter
	Plant standing dead	stand
	Above-ground primary product	ANPP
	Below-ground primary product	BNPP
	Below-ground primary product (0-20cm)	BNPP_0
	Below-ground primary product (20-40cm)	BNPP_2
	Net primary product	NPP
	The ratio of ANPP to BNPP	ANPP/ BNPP
Plant Community	Grass percentage	Grass
	Forb percentage	Forb
	Sedge percentage	Sedge
	Species richness	Richness
Microbial community	Fungi: Bacteria	FtoB
	Gram-positive: Gram-negative	PtoN

	Arbuscular Mycorrhizal Fungi: Saprotrophic Fungi	AMFtoSF
Soil Chemistry	Soil organic carbon	SOC
	Total nitrogen	TN
	Microbial biomass carbon	MBC
	Microbial biomass nitrogen	MBN

Supplementary Table 3 T_{opt} of respiration components under ambient (control) conditions. All values are reported in degrees Celsius (°C).

Component	Mean T_{opt}	Median T_{opt}	Lower T_{opt}	Upper T_{opt}
R_{eco}	14.02134	13.44144	13.12970	14.91299
R_{micro}	14.09011	13.77205	12.65259	15.52762
R_{plant}	14.10077	13.74668	12.94479	15.25675
R_{above}	13.81303	13.22877	12.22415	15.40191
R_{root}	13.20421	12.88763	11.92388	14.48453

Supplementary Table 4 Regression result of T_{opt} of respiration components and soil temperature.

Component	Adjusted R^2	Slope (95% CI)	*p*
R_{plant}	0.741893	(0.77, 1.00)	<0.0001
R_{micro}	0.527746	(0.69, 1.04)	<0.0001
R_{above}	0.665397	(0.71, 0.97)	<0.0001
R_{root}	0.642205	(0.77,1.06)	<0.0001

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