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A global dataset of soil organic carbon mineralization in response to incubation temperature changes

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TABLE S1. Temperature response functions used in 69 carbon models. Carbon models simulate carbon cycling process and, in some cases, the associated energy and water exchanges, while land carbon models are their submodules specifically representing terrestrial carbon cycling processes.

Types	Temperature response functions	Land carbon models	Carbon models	Models	References
1	$f(T) = 1.5^{\frac{T-25}{10}}$	CLM5	CLM5	CESM2	Emmons et al. (2020)
				NorESM2-LM	Seland et al. (2019)
				NorESM2-MM	Bentsen et al. (2019)
				CESM2	Danabasoglu (2019a)
				CESM2-FV2	Danabasoglu (2020a)
				CESM2-WACCM	Danabasoglu (2019b)
				CESM2-WACCM-FV2	Danabasoglu (2020b)
		CLM4.5	CLM4.5	CMCC-CM2-SR5	Oleson et al. (2013)
				CMCC-ESM2	Lovato et al. (2021)
		CLM4	CLM4	FIO-ESM-2-0	Song et al. (2019)
				SAM0-UNICON	Park and Shin (2019)
				TaiESM1	Tseng et al. (2020)
				NorCPM1	Bethke et al. (2019)
		ELM	ELM	E3SM-1-1-ECA	Burrows et al. (2020)
		JULES	CABLE2.5+JULES	ACCESS-CM2	Dix et al. (2019)
	$f(T) = 2^{\frac{T-30}{10}}$	ORCHIDEE	ORCHIDEE	IPSL-CM5A2-INCA	Boucher et al. (2020a)
		ISBA-CTRIP	ISBA-CTRIP	CNRM-ESM2-1	Séférian et al. (2019)

		ORCHIDEE branch 2.0	ORCHIDEE branch 2.0	IPSL-CM6A-LR	Boucher et al. (2020b)
	$f(T) = 2^{\frac{T-25}{10}}$	JULES-ES-1.0	JULES-ES-1.0	UKESM1-0-LL	Good et al. (2019)
	$f(T) = 2^{\frac{T-10}{10}}$	CoLM1.0	CoLM1.0	CAMS-CSM1-0	Rong (2019)
				CAS-ESM2-0	Chai (2020)
		INM-LND1	INM-LND1	INM-CM5-0	Volodin et al. (2017)
				INM-CM4-8	Volodin et al. (2019)
	$f(T) = 1.71^{\frac{T-35}{10}}$	CASA-CNP	CABLE2.4+CASA-CNP	ACCESS-ESM1.5	Ziehn et al. (2019)
2	$f(T) = \begin{cases} 2.1^{\frac{T-35}{10}}, & T \leq 35 \\ 1.0, & T > 35 \end{cases}$	CANDY	CANDY	CANDY	Franko et al. (1995)
	$f(T) = \frac{47.9}{1 + exp\left(\frac{106}{T + 18.3}\right)}$	JULES-HadGEM3-GL7.1	JULES-HadGEM3-GL7.1	UK-ESM1.0-LL	Sellar et al. (2019)
		RothC	JULES-HadGEM3-GL7.1	UK-ESM1-0-LL	Armstrong et al. (2001)
			RothC	RothC	Coleman and Jenkinson (1996)
	$f(T) = 0.0326 + 0.00351 \cdot T^{1.652} - \left(\frac{T}{41.748}\right)^{7.19}$	LPJ-GUESS	LPJ-GUESS	EC-Earth3-CC	Smith et al. (2014)

3	$f(T)=\begin{cases}0.01, & -5 \geq T \\ 0.04, & -5 < T \leq 0 \\ 0.04+0.06 \cdot T, & 0 < T \leq 5 \\ 0.07+0.016 \cdot (T-5), & 5 < T \leq 10 \\ 0.15+0.03 \cdot (T-10), & 10 < T \leq 35 \\ 0.95, & 35 < T \leq 40 \\ 0.95-0.135 \cdot (T-40), & 40 < T \leq 47 \\ 0, & 47 < T \end{cases}$	AVIM2	BCC-AVIM2	BCC-CSM2-MR	Ji and Yu (1999)
	$f(T)=0.56+0.465 \cdot arctan\big(0.097 \cdot (T-15.7)\big)$	CENTURY	CENTURY	CENRUTY	Parton et al. (1987)
	$f(T)=Q_{10}^{\frac{T-15}{10}}$ $Q_{10}=1.44+0.56 \cdot tanh\big(0.075 \cdot (46-T)\big)$	CLASS-CTEM	CLASS-CTEM	CanESM5	Swart et al. (2019)
	$f(T)=T_1^{0.2} \cdot T_2$ $T_1=\frac{45-T}{10}$, $T_2=\exp\,(0.076 \cdot (1-T_1^{2.63}))$	LM3	GFDL-ESM2M	GFDL-ESM2M	Shevliakova et al. (2009)
	$f(T)=0.68 \cdot exp\big(0.1 \cdot (T-7.1)\big)$	PnET	PnET-CN	PnET-CN	Aber et al. (1997)
4	$f(T)=exp\left(3.36 \cdot \left(\frac{T-40}{T+46.05}\right)\right)$	K2000	K2000	K2000	Kirschbaum (2000)
	$f(T)=exp\left(\frac{E \cdot (T-T_{20})}{R \cdot (273.15+T) \cdot (273.15+T_{20})}\right)$ $R=8.314\,J\,K^{-1}\,mol^{-1}$, $E=55.5\,kJ\,mol^{-1}$, $T_{20}=20$ ℃	SOILCO2	SOILCO2	SOILCO2	Šimůnek and Suarez (1993)
	$f(T)=exp\left(308.56 \cdot \left(\frac{1}{56.02}-\frac{1}{T+46.02}\right)\right)$	MATSIRO VISIT-s	MATSIRO VISIT-s	MIROC-ES2L	Yamamoto et al. (2019)
		VISIT-e 1	MATSIRO visit-e 1	MIROC6	Tatebe et al. (2019)
		LPJ	MRI-LCCM2	MRI-ESM-2.0	Yukimoto et al. (2019)
		MATSIRO visit-e 1	MATSIRO visit-e 1	MIROC-ES2L	Hajima et al. (2020)

		MRI-LCCM2	MRI-LCCM2	MRI-LCCM2	Obata and Adachi (2019)
NONE	NONE	NONE	CIESM-LM	CIESM	Huang (2019)
			ISBA-CTRIP	CNRM-CM6-1	Voldoire (2018)
				CNRM-CM6-1-HR	Voldoire (2019)
			ELM	E3SM-1-0	Bader et al. (2019)
			HTESSEL	EC-Earth3-AerChem	Consortium (2020)
			HTESSEL + LPJ-GUESS	EC-Earth3-Veg	Consortium (2019)
			CLM4.0 / CAS-LSM	FGOALS-f3-L	Yu (2019)
				FGOALS-g3	Li et al. (2020)
			LM4.0	GFDL-CM4	Silvers et al. (2018)
			GISS LSM	GISS-E2-1-G	Studies (2018)
				GISS-E2-1-H	Studies (2019a)
				GISS-E2-2-G	Studies (2019b)
			JULES-HadGEM3-GL7.1	HadGEM3-GC31-LL	Gregory (2021)
				HadGEM3-GC31-MM	Jackson (2020)
			NOAH LSM 2.7.1	IITM-ESM	Panickal et al. (2019)
			ORCHIDEE	IPSL-CM6A-LR	Boucher et al. (2018)
			JULES-HadGEM3-GL7.1	KACE-1-0-G	Byun et al. (2019)
			Manabe bucket scheme	MCM-UA-1-0	Stouffer (2019)
			JSBACH3.1	NESM3	Cao and Wang (2019)

		MPI-ESM-1-2-HR	Mauritsen et al. (2019)
		MPI-ESM-1-2-LR	Mauritsen et al. (2019)
	JSBACH3.2	AWI-CM-1-1-MR	Semmler et al. (2018)
		MPI-ESM-1-2-HAM	Neubauer et al. (2019)
		MPI-ESM1.2-LR	Wieners et al. (2019)
	MATSIRO6.0	MIROC6	Tatebe et al. (2019)
	HAL 1.0	MRI-ESM-2-0	Yukimoto et al. (2019)

3

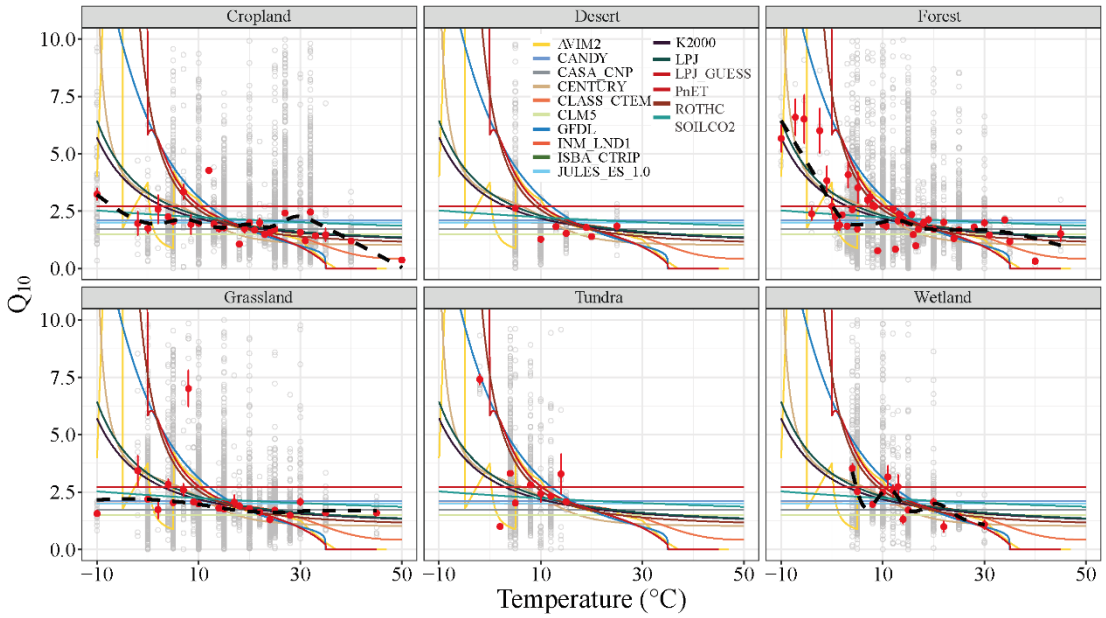

FIGURE S1. Performance assessment of soil carbon temperature response functions in Earth System Models across different ecosystem types. Solid lines in different colors represent the temperature sensitivity (Q_{10}) values predicted by the temperature response functions. Gray open points represent observed Q_{10} values at different temperatures, while the black dashed line shows the best-fit relationship between observed Q_{10} and temperature based on locally weighted polynomial regression. Red points indicate the observed mean values under the corresponding temperatures, and error bars represent one standard error of the observations. Note that the number of independent temperature observations in deserts and tundra is insufficient for curve fitting.

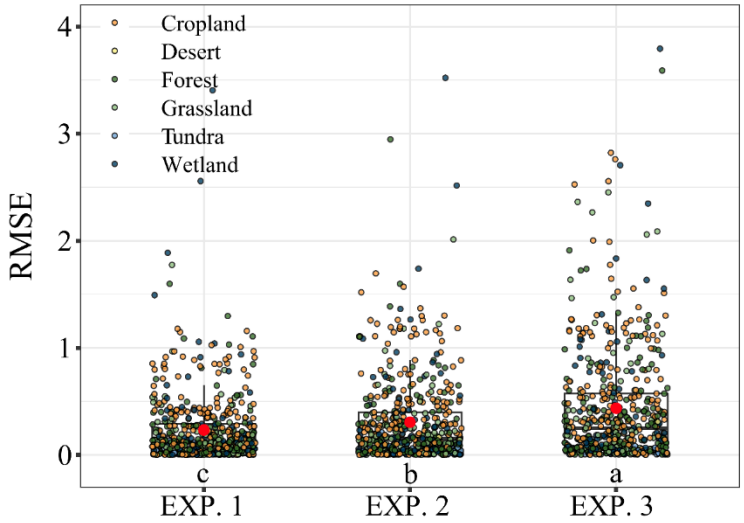

FIGURE S2. Root mean square error (RMSE) between the observed carbon mineralization rates and those predicted by the three simulation experiments. EXP. 1 represents the best-fit model and serves as the baseline for comparison, EXP. 2 aims to assess the relative importance of the intrinsic temperature response, and EXP. 3 aims to assess the relative importance of external environmental constraints. Different letters indicate significant difference (p<0.05).

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