Supplementary Online Materials

for

Historical dynamics of terrestrial carbon during 1901-2016 as simulated by the CLM-Microbe model

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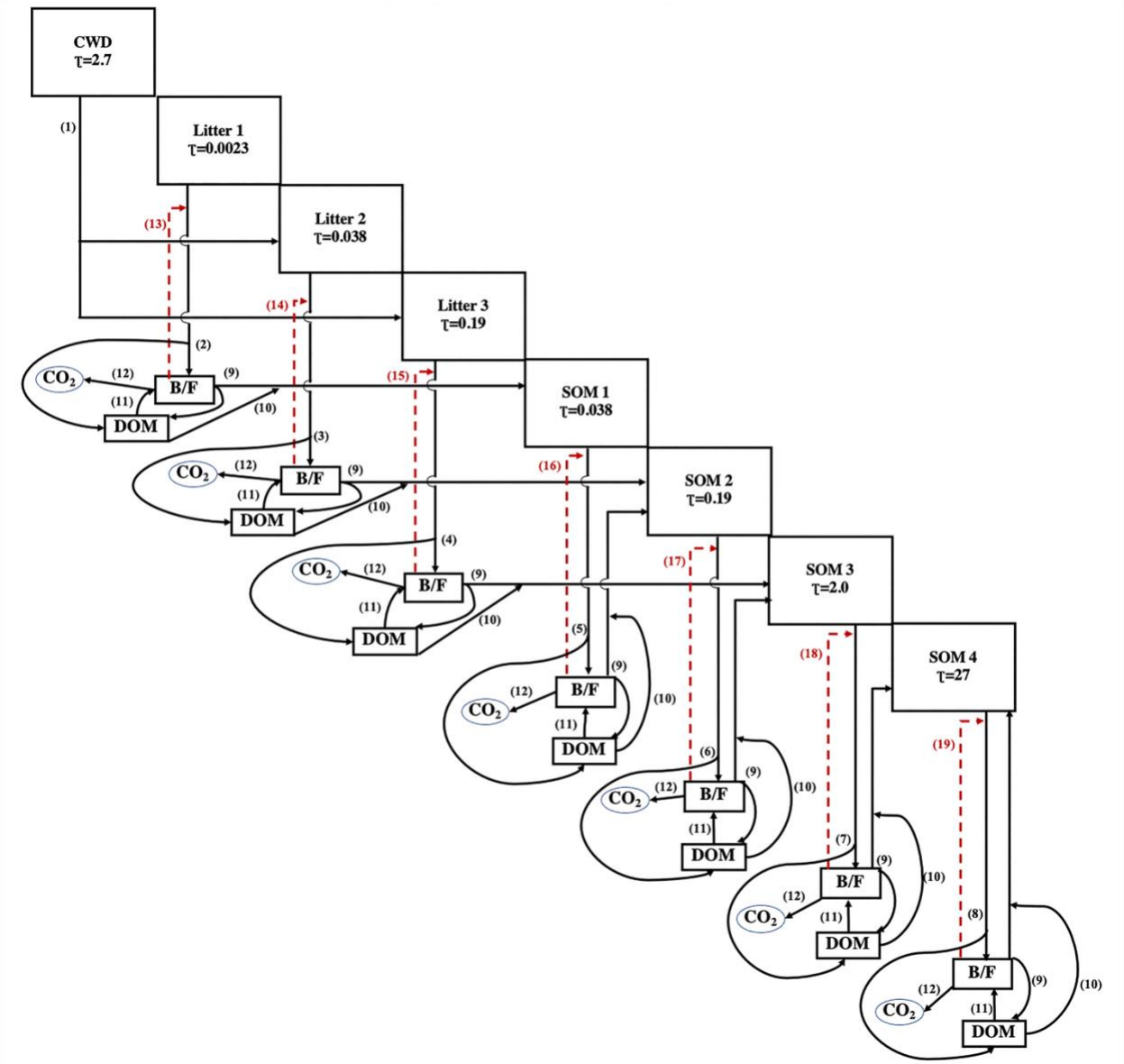

Fig. S1. Conceptual diagram showing the key processes and the roles of fungi and bacteria in the CLM-Microbe model. CWD, coarse woody debris; SOM, soil organic matter; B, bacteria; F, fungi; DOM, dissolved organic matter. In the CLM-Microbe model, number in the box means turnover time of each pool. Black solid lines indicate transitions in the CLM-Microbe model, which generally represents processes such as 1) decomposition of coarse woody debris, 2) litter 1 decomposition, 3) litter 2 decomposition, 4) litter 3 decomposition, 5) soil organic matter 1 decomposition, 6) soil organic matter 2 decomposition, 7) soil organic matter 3 decomposition, 8) soil organic matter 4 decomposition, 9) fungal and bacterial lysis, 10) dissolved organic matter adsorption, 11) dissolved organic matter uptake by fungal and bacterial, and 12) fungal and bacterial respiration. Red dash lines represent regulatory role of fungi and bacteria on the process, including fungi and bacteria regulation on 13) litter 1, 14) litter 2, 15) litter 3, 16) soil organic matter 1, 17) soil organic matter 2, 18) soil organic matter 3, and 19) soil organic matter 4 decomposition (He et al., 2021).

Table S1. Key model parameters in processes involving fungal and bacterial biomass

Symbol	Range [a]	Unit	Description	Reference
k_dom	0.0025-0.5	d^{-1}	decomposition rate constant of DOM	(Wheeler et al., 1996; Kirchman et al., 1991; Cherrier et al., 1996)
k_bacteria	0.00143-2	d^{-1}	lysis rate constant of bacteria	(Rousk and Bååth, 2007, 2011; Moore et al., 2005; Schippers et al., 2005)
k_fungi	0.00027-0.05	d^{-1}	lysis rate constant of fungi	(Thornton and Rosenbloom, 2005; Rousk and Bååth, 2011; Moore et al., 2005; Wallander et al., 2004)
m_rf_s1m	0-1		fraction factor quantifying carbon from SOM1 to microbes	Calibrated
m_rf_s2m	0-1		fraction factor quantifying carbon from SOM2 to microbes	Calibrated
m_rf_s3m	0-1		fraction factor quantifying carbon from SOM3 to microbes	Calibrated
m_rf_s4m	0-1		fraction factor quantifying carbon from SOM4 to microbes	Calibrated
m_batm_f	0-1		fraction factor quantifying carbon respired by bacteria	Calibrated
m_bdom_f	0-1		fraction factor quantifying carbon from DOM to bacteria	Calibrated
m_bs1_f	0-1		fraction factor quantifying carbon from bacteria to SOM1	Calibrated
m_bs2_f	0-1		fraction factor quantifying carbon from bacteria to SOM2	Calibrated
m_bs3_f	0-1		fraction factor quantifying carbon from bacteria to SOM3	Calibrated
m_fatm_f	0-1		fraction factor quantifying carbon respired by fungi	Calibrated
m_fdom_f	0-1		fraction factor quantifying carbon from DOM to fungi	Calibrated
m_fs1_f	0-1		fraction factor quantifying carbon from fungi to SOM1	Calibrated
m_fs2_f	0-1		fraction factor quantifying carbon from fungi to SOM2	Calibrated
m_fs3_f	0-1		fraction factor quantifying carbon from fungi to SOM3	Calibrated
m_domb_f	0-1		fraction factor quantifying carbon from DOM to bacteria	Calibrated
m_domf_f	0-1		fraction factor quantifying carbon from DOM to fungi	Calibrated
m_doms1_f	0-1		fraction factor quantifying carbon from DOM to SOM1	Calibrated
m_doms2_f	0-1		fraction factor quantifying carbon from DOM to SOM2	Calibrated
m_doms3_f	0-1		fraction factor quantifying carbon from DOM to SOM3	Calibrated
cn_bacteria	3-12		C:N ratio of bacteria	(Strickland and Rousk, 2010)
cn_fungi	3-60		C:N ratio of fungi	(Strickland and Rousk, 2010)
cn_dom	4.2-185		C:N ratio of DOM	(Sinsabaugh et al., 2016)
CUEmax	0.46-0.9		maximum carbon use efficiency of microbes	(Gommers et al., 1988; Sinsabaugh et al., 2013; Sinsabaugh et al., 2016)

[a]The values may not be the same as those from literature sources due to unit conversion.

Table S2. Validation and atmospheric forcing datasets used in this study

Variables	Dataset	Source
Gross and net primary productivity	MODIS gridded datasets	Zhao et al. (2005)
Heterotrophic and soil respiration	Global Gridded 1-km Annual Soil Respiration Database	Warner et al. (2019)
Soil organic carbon (0-1 m)	Harmonized World Soil Database	Wieder (2014)
Soil organic carbon (0-30 cm)	Global Soil Organic Carbon Map	Fao (2018)
Fungal and bacterial biomass carbon (0-30 cm)	Global Topsoil Fungal and Bacterial Biomass Carbon Dataset	He et al. (2020)
Microbial biomass carbon (0-1 m)	Global Soil Microbial Biomass Carbon, Nitrogen, and Phosphorus Dataset	Xu et al. (2013)
Dissolved organic carbon (0-30 cm & 0-1 m)	Global Dissolved Organic Carbon Dataset	Guo et al. (2020)
Meteorological Forcing	CRUNCEP Version 7 - Atmospheric Forcing Data for the Community Land Model	Viovy (2018)

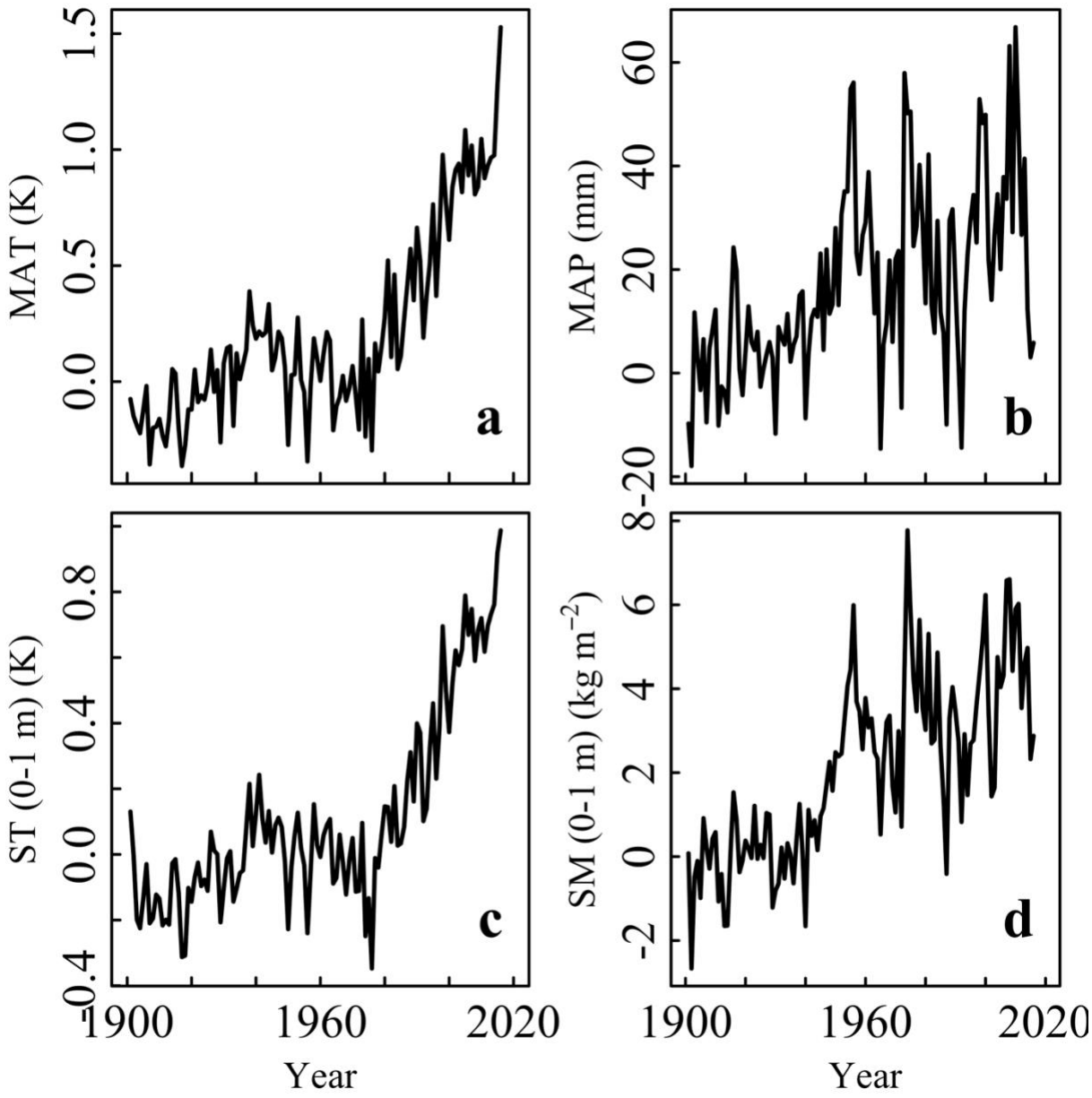

Fig. S2 Temporal variations of annual deviations in (a) MAT, (b) MAP, (c) ST of top 1m, and (d) SM of top 1m weighted by area in the CLM-Microbe model from 1901-1910. The baseline was the ten-year average of corresponding variables during 1901-1910. MAT, mean annual temperature; MAP, mean annual precipitation; ST, soil temperature; SM, soil moisture.

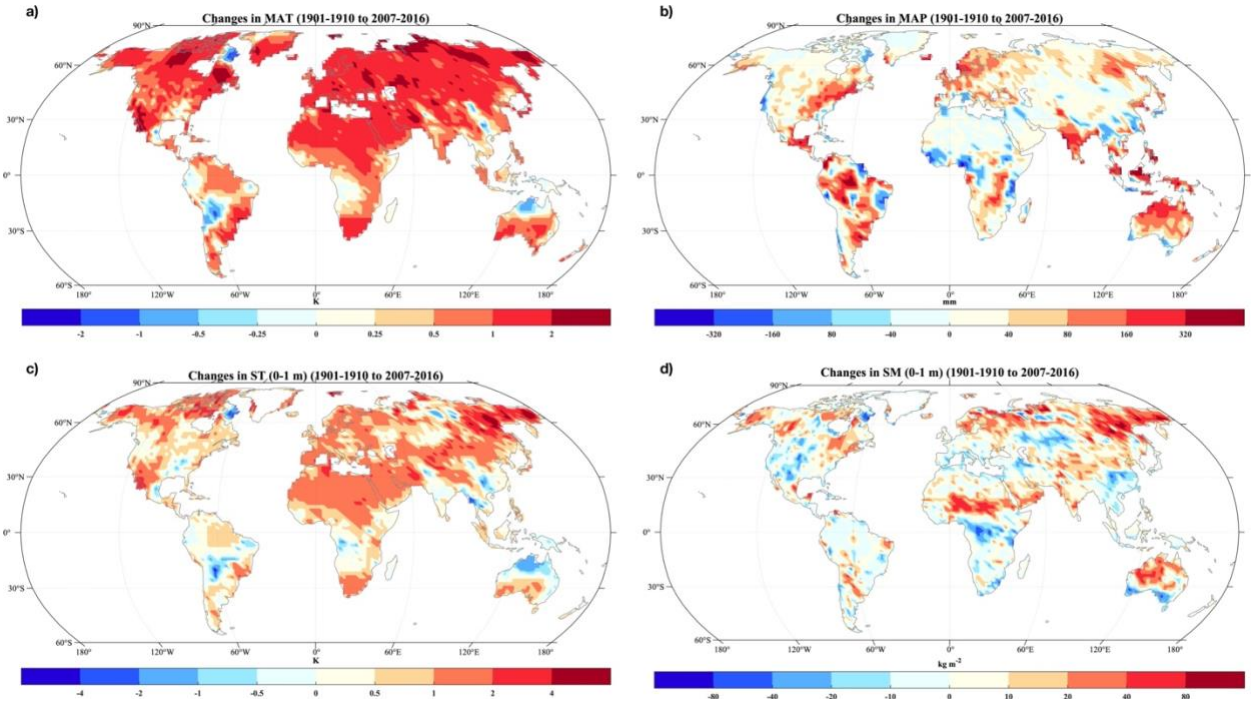

Fig. S3 Changes of (a) MAT, (b) MAP, (c) ST (0-1 m), and (d) SM (0-1 m) in 2007-2016 vs. 1901-1910. MAT, mean annual temperature; MAP, mean annual precipitation; ST, soil temperature; SM, soil moisture.

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