Supplementary Materials for

Soil and soil CO_2 magnify greenhouse effect

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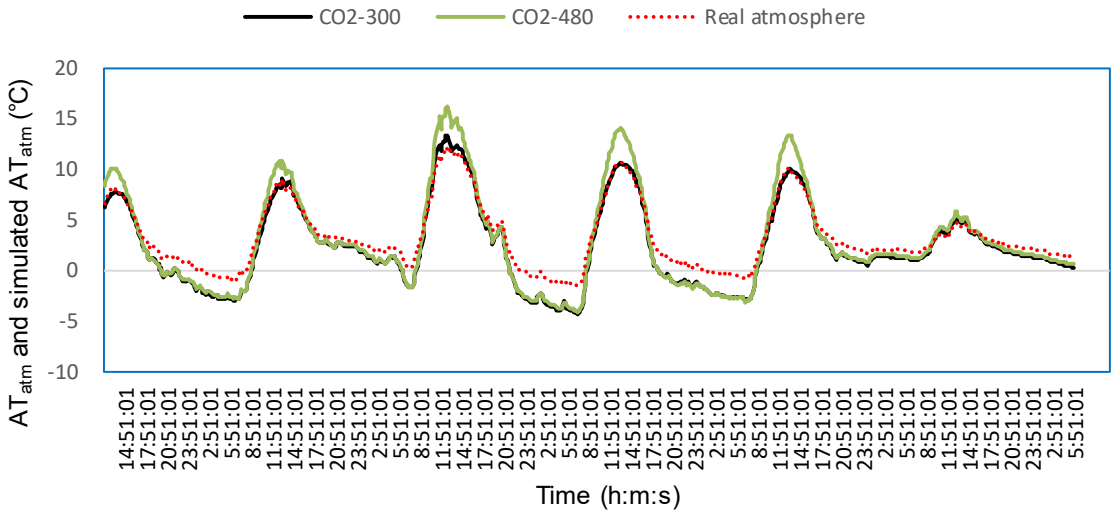

Fig. S1. The comparisons of change patterns of temperatures in the real atmospheric air (AT_{atm}) at block center and in the simulated atmospheric air with CO_2 concentration of 300 ppm and 480 ppm during the six experimental days.

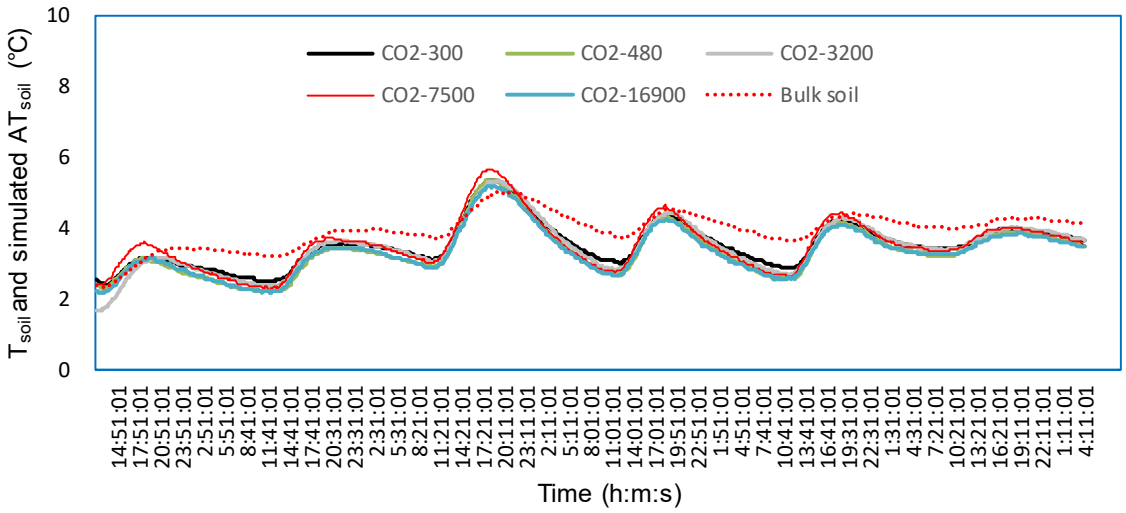

Fig. S2. The comparisons of change pattern of temperatures in bulk soil (T_{soil}) at block center and in the simulated soil air (AT_{soil}) with five levels of CO_2 concentration (300 ppm – 16900 ppm) during the six experimental days.

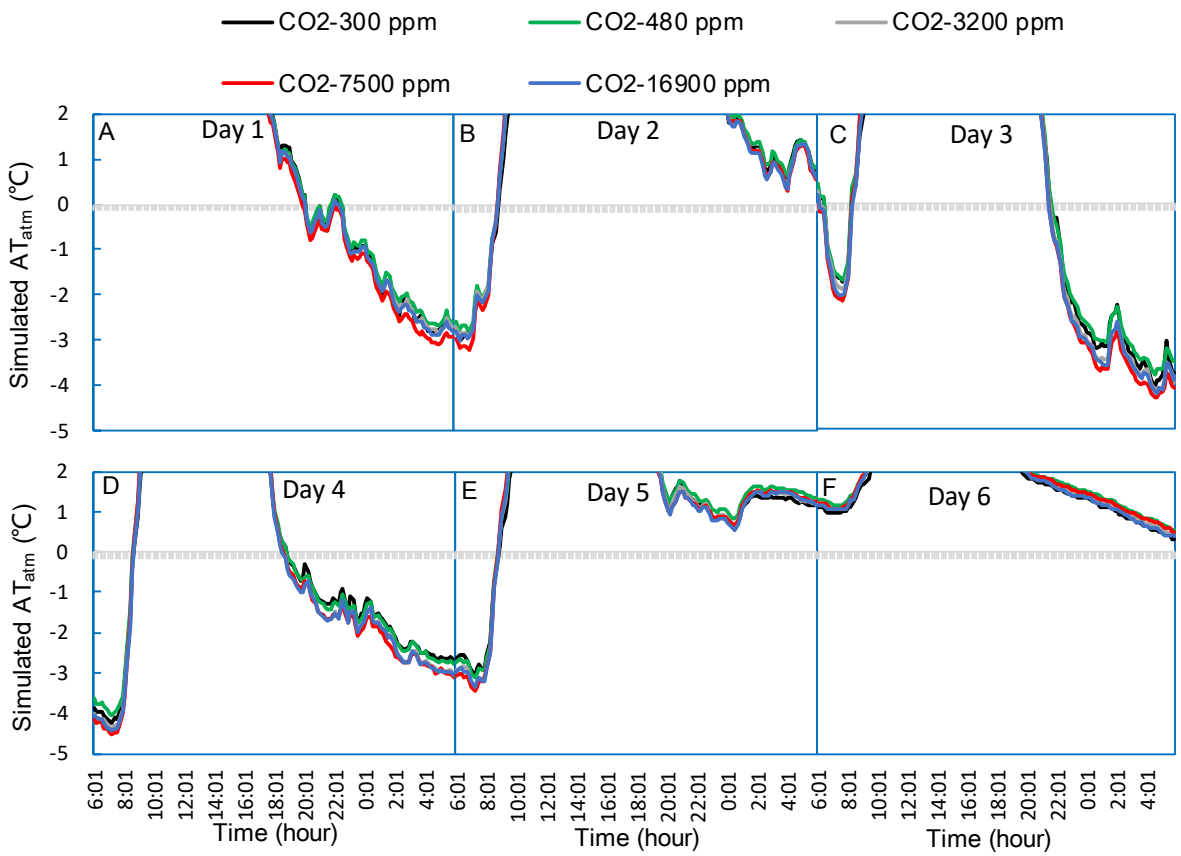

Fig. S3. The negative effect of increased CO_2 concentration on temperature in the simulated atmospheric air at nighttime and early morning during which the environmental temperature was lower than 2℃.

Table S1. The repeated measure ANOVA results of CO_2 concentration effects on temperature in the simulated atmospheric air during the six experimental days. NA: data not available; †noted that the air temperature in mesocosms with treatment of L480 was likely to be higher than that of L7500 and L16900 ($P = 0.051$ and $P = 0.079$, respectively); ‡noted that the air temperature in mesocosms with treatment of L480 was likely to be higher than that of L300 ($P = 0.072$); ¶ noted that the air temperature in mesocosms with treatment of L300 was likely to be lower than that of L3200 and L7500 ($P = 0.079$ and $P = 0.079$, respectively); §noted that the air temperature in mesocosms with treatment of L300 was likely to be lower than that of L3200 and L7500 ($P = 0.058$ and $P = 0.074$, respectively); ‖noted that the air temperature in mesocosms with treatment of L300 was likely to be lower than that of L480 ($P = 0.051$). The upward and downward arrows indicated that some of the treatments with higher CO_2 concentration may cause increased and decreased air temperature in the mesocosms, respectively; the arrow with dashed line indicated that the CO_2 concentration effect on air temperature in mesocosms was not significant but deserved to be noticed ($0.05 < P < 0.1$). The difference letter indicated significant effect of CO_2 concentration on air temperature ($P < 0.05$).

Days	Periods	Time (h: m)	Air temperature in mesocosms (°C, Mean ± SE)					*F* and *P* value
			Levels of CO_2 concentration in mesocosms (ppm)					
			L300	L480	L3200	L7500	L16900	
Day 1	Atom-P1: Early morning with lower heat radiation	NA	NA	NA	NA	NA	NA	NA
	Atom-P2: Daytime with higher	12:01-13:11	7.06 ±	9.44 ±	10.49 ±	12.77 ±	10.87 ±	$F_{4,15} = 12.62$;

	and increasing heat radiation		0.18c	0.24b	0.22b	0.27a	0.31b	$P < 0.001$; ↑↓
	Atom-P3: Daytime with higher	13:21-16:41	6.56 ±	7.73 ±	8.27 ±	8.97 ±	8.51 ±	$F_{4,15} = 11.83$;
	and decreasing heat radiation		0.26c	0.41b	0.47ab	0.59a	0.51ab	$P < 0.001$; ↑
	Atom-P4: Nighttime with lower	0:01-5:51	-2.19 ±	-2.05 ±	-2.19 ±	-2.43 ±	-2.24 ±	$F_{4,15} = 1.86$;
	heat radiation		0.09ab	0.09a	0.09ab	0.10b	0.09ab	$P = 0.170$; ↓
Day 2	Atom-P1: Early morning with	6:01-8:01	-2.57 ±	-2.41 ±	-2.53 ±	-2.78 ±	-2.60 ±	$F_{4,15} = 1.80$;
	lower heat radiation		0.11ab	0.10a	0.11ab	0.12b	0.11ab	$P = 0.182$; ↓
	Atom-P2: Daytime with higher	9:31-13:21	6.03 ±	7.58 ±	8.14 ±	9.16 ±	8.17 ±	$F_{4,15} = 14.92$;
	and increasing heat radiation		0.44c	0.57b	0.60b	0.68a	0.60b	$P < 0.001$; ↑↓
	Atom-P3: Daytime with higher	13:31-16:31	7.40 ±	8.10 ±	8.44 ±	8.67 ±	8.23 ±	$F_{4,15} = 24.78$;
	and decreasing heat radiation		0.28d	0.37c	0.40ab	0.44a	0.39bc	$P < 0.001$; ↑↓
	Atom-P4: Nighttime with lower	0:01-5:51	1.22 ±	1.31 ±	1.15 ±	1.14 ±	1.12 ±	$F_{4,15} = 2.54$;
	heat radiation		0.07ab	0.07a	0.07b	0.08b	0.08b	$P = 0.083$; ↓
Day 3	Atom-P1: Early morning with	6:01-8:21	-0.91 ±	-0.84 ±	-1.04 ±	-1.22 ±	-1.17 ±	$F_{4,15} = 4.40$;
	lower heat radiation		0.20a	0.21a	0.21ab	0.23b	0.22b	$P = 0.015$; ↓
	Atom-P2: Daytime with higher	9:21-12:31	9.66 ±	11.32 ±	12.00 ±	13.30 ±	12.02 ±	$F_{4,15} = 11.63$;
	and increasing heat radiation		0.69c	0.86b	0.93b	1.05a	0.96b	$P < 0.001$; ↑↓

	Atom-P3: Daytime with higher and decreasing heat radiation	12:41-15:21	12.07 ± 0.15c	14.33 ± 0.26b	15.02 ± 0.30ab	15.95 ± 0.42a	15.15 ± 0.34ab	$F_{4,15}$ = 9.44; P = 0.001; ↑
	Atom-P4: Nighttime with lower heat radiation	0:00-5:51	-3.26 ± 0.08ab	-3.17 ± 0.07a	-3.48 ± 0.07ab	-3.70 ± 0.07b	-3.53 ± 0.07ab	$F_{4,15}$ = 1.77; P = 0.188; ↓
Day 4	Atom-P1: Early morning with lower heat radiation	6:01-8:31	-3.50 ± 0.28a	-3.31 ± 0.28a	-3.66 ± 0.28a	-3.77 ± 0.30a	-3.72 ± 0.27a	$F_{4,15}$ = 1.49; P = 0.254†; ↕
	Atom-P2: Daytime with higher and increasing heat radiation	9:11-13:11	7.11 ± 0.53c	9.01 ± 0.75b	9.56 ± 0.81ab	10.40 ± 0.90a	9.62 ± 0.83ab	$F_{4,15}$ = 7.68; P = 0.001; ↑
	Atom-P3: Daytime with higher and decreasing heat radiation	13:21-17:01	8.90 ± 0.37c	10.74 ± 0.56ab	11.25 ± 0.62a	11.79 ± 0.68a	11.25 ± 0.66a	$F_{4,15}$ = 9.30; P = 0.001; ↑
	Atom-P4: Nighttime with lower heat radiation	0:01-5:51	-2.18 ± 0.08a	-2.23 ± 0.08a	-2.44 ± 0.08a	-2.52 ± 0.07a	-2.46 ± 0.08a	$F_{4,15}$ = 0.367; P =0.828
Day 5	Atom-P1: Early morning with lower heat radiation	6:01-8:41	-2.82 ± 0.23a	-2.41 ± 0.21a	-2.60 ± 0.22a	-2.69 ± 0.23a	-2.65 ± 0.21a	$F_{4,15}$ = 0.327; P =0.856
	Atom-P2: Daytime with higher and increasing heat radiation	9:51-13:11	7.96 ± 0.65b	8.74 ± 0.73b	9.43 ± 0.80ab	10.71 ± 0.93a	9.70 ± 0.82ab	$F_{4,15}$ = 2.80; P = 0.064; ↑
	Atom-P3: Daytime with higher	13:21-16:21	10.08 ±	10.76 ±	11.37 ±	11.98 ±	11.36 ±	$F_{4,15}$ = 2.26;

	and decreasing heat radiation		0.35b	0.45ab	0.49ab	0.63a	0.51ab	P = 0.112;
	Atom-P4: Nighttime with lower	0:01-5:51	1.25 ±	1.42 ±	1.29 ±	1.31 ±	1.26 ±	$F_{4,15}$ = 1.81;
	heart radiation		0.04b	0.04a	0.04ab	0.04ab	0.05b	P =0.181,
Day 6	Atom-P1: Early morning with	6:01-7:41	1.10 ±	1.25 ±	1.13 ±	1.15 ±	1.12 ±	$F_{4,15}$ = 1.13;
	lower heat radiation		0.02a	0.02a	0.01a	0.02a	0.01a	P =0.379‡,
	Atom-P2: Daytime with higher	11:21-13:01	4.60 ±	4.62 ±	4.92 ±	4.92 ±	4.89 ±	$F_{4,15}$ = 1.90;
	and increasing heat radiation		0.19a	0.19a	0.20a	0.20a	0.20a	P =0.162¶,
	Atom-P3: Daytime with higher	13:11-14:51	5.14 ±	5.17 ±	5.42 ±	5.41 ±	5.38 ±	$F_{4,15}$ = 1.96;
	and decreasing heat radiation		0.09a	0.09a	0.11a	0.11a	0.11a	P =0.152§,
	Atom-P4: Nighttime with lower	0:01-5:51	0.92 ±	1.05 ±	0.93 ±	1.01 ±	0.87 ±	$F_{4,15}$ = 1.81;
	heat radiation		0.05ab	0.05a	0.05ab	0.05a	0.05b	P =0.181‖,

Table S2. The repeated measure ANOVA results of CO_2 concentration effects on the air temperature of the simulated soil air in mesocosms covered by 10 cm layer of soil during the six experimental days. †noted that the air temperature in mesocosms with treatment of L7500 was likely to be higher than that of L300 (P = 0.06); ‡noted that the air temperature in mesocosms with treatment

of L7500 was likely to be higher than that of L3200 (P = 0.073). NA: data not available. The upward and downward arrows indicated that some of the treatments with higher CO_2 concentration may cause increased and decreased air temperature in the mesocosms, respectively. The difference letter indicated significant effect of CO_2 concentration on air temperature ($P < 0.05$).

Days	Periods	Time (h: m)	Air temperature in mesocosms (℃, Mean ± SE) Levels of CO_2 concentration in mesocosms (ppm)					F and P value
			L300	L480	L3200	L7500	L16900	
Day 1	Soil-P1: Morning and early afternoon with lower soil air temperature	NA	NA	NA	NA	NA	NA	NA
	Soil-P2: Daytime and early nighttime with higher and increasing soil air temperature	14:01-18:41	2.86 ± 0.06ab	2.85 ± 0.11ab	2.54 ± 0.08b	3.22 ± 0.06a	2.78 ± 0.04ab	$F_{4,15}$ = 1.56; P = 0.236; ↑
	Soil-P3: Nighttime with higher and decreasing soil air temperature	18.51-0:31	3.09 ± 0.02ab	2.93 ± 0.04b	3.09 ± 0.05ab	3.27 ± 0.03a	2.98 ± 0.02b	$F_{4,15}$ = 2.30; P = 0.106; ↑↓
	Soil-P4: Nighttime with lower soil air temperature	0:41-5:51	2.83 ± 0.03a	2.56 ± 0.03a	2.77 ± 0.05a	2.75 ± 0.05a	2.59 ± 0.02a	$F_{4,15}$ = 1.08; P = 0.40
Day 2	Soil-P1: Morning and early afternoon	6:01-12:01	2.58 ±	2.28 ±	2.46 ±	2.41 ±	2.29 ±	$F_{4,15}$ = 0.89;

	with lower soil air temperature		0.03a	0.04a	0.05a	0.06a	0.03a	$P = 0.493$
	Soil-P2: Daytime and early nighttime with higher and increasing soil air temperature	15:21-21:01	3.29 ± 0.04ab	3.11 ± 0.02b	3.30 ± 0.04ab	3.44 ± 0.04a	3.16 ± 0.01b	$F_{4,15} = 2.22$; $P = 0.116$; ⇅
	Soil-P3: Nighttime with higher and decreasing soil air temperature	21:11-1:51	3.55 ± 0.05a	3.40 ± 0.03a	3.59 ± 0.06a	3.63 ± 0.04a	3.40 ± 0.03a	$F_{4,15} = 0.82$; $P = 0.531$
	Soil-P4: Nighttime with lower soil air temperature	2:01-5:51	3.45 ± 0.05a	3.24 ± 0.04a	3.47 ± 0.07a	3.44 ± 0.06a	3.26 ± 0.04a	$F_{4,15} = 0.70$; $P = 0.604$
Day 3	Soil-P1: Morning and early afternoon with lower soil air temperature	6:01-10:31	3.26 ± 0.05a	3.03 ± 0.04a	3.22 ± 0.07a	3.16 ± 0.06a	3.02 ± 0.04a	$F_{4,15} = 0.63$; $P = 0.649$
	Soil-P2: Daytime and early nighttime with higher and increasing soil air temperature	12:11-18:41	4.33 ± 0.02b	4.28 ± 0.04b	4.23 ± 0.02b	4.56 ± 0.02a	4.18 ± 0.03b	$F_{4,15} = 4.17$; $P = 0.018$; ⇅
	Soil-P3: Nighttime with higher and decreasing soil air temperature	18:51-22:11	5.21 ± 0.03ab	5.19 ± 0.03b	5.24 ± 0.05ab	5.42 ± 0.03a	5.07 ± 0.02b	$F_{4,15} = 3.04$; $P = 0.051$†; ⇅
	Soil-P4: Nighttime with lower soil air	0:01-5:51	4.08 ±	3.91 ±	4.10 ±	3.96 ±	3.85 ±	$F_{4,15} = 0.47$;

	temperature		0.04a	0.04a	0.07a	0.06a	0.05a	P =0.758
Day 4	Soil-P1: Morning and early afternoon	6:01-12:51	3.24 ±	2.94 ±	3.08 ±	2.98 ±	2.91 ±	$F_{4,15}$ = 0.71;
	with lower soil air temperature		0.04a	0.05a	0.06a	0.06a	0.06a	P =0.599
	Soil-P2: Daytime and early nighttime	14:41-19:21	3.92 ±	3.82 ±	3.89 ±	4.11 ±	3.78 ±	$F_{4,15}$ = 2.50;
	with higher and increasing soil air		0.03ab	0.02b	0.04ab	0.04a	0.01b	P = 0.087‡; ↑↓
	temperature							
	Soil-P3: Nighttime with higher and	19:31-22:31	2.44 ±	2.49 ±	2.47 ±	2.55 ±	2.22 ±	$F_{4,15}$ = 0.02;
	decreasing soil air temperature		0.63a	0.60a	0.65a	0.66a	0.65a	P = 0.999
	Soil-P4: Nighttime with lower soil air	0:01-5:51	1.49 ±	1.46 ±	1.45 ±	1.52 ±	1.22 ±	$F_{4,15}$ = 0.02;
	temperature		0.49a	0.46a	0.48a	0.50a	0.49a	P =0.999
Day 5	Soil-P1: Morning and early afternoon	6:01-13:11	3.02 ±	2.71 ±	2.86 ±	2.78 ±	2.70 ±	$F_{4,15}$ = 0.73;
	with lower soil air temperature		0.03a	0.04a	0.05a	0.06a	0.05a	P =0.584
	Soil-P2: Daytime and early nighttime	14:41-20:01	3.81 ±	3.71 ±	3.77 ±	3.99 ±	3.66 ±	$F_{4,15}$ = 2.49;
	with higher and increasing soil air		0.03ab	0.02b	0.04ab	0.04a	0.01b	P = 0.087; ↑↓
	temperature							
	Soil-P3: Nighttime with higher and	20:11-23:31	4.09±	4.01 ±	4.17 ±	4.21 ±	3.96 ±	$F_{4,15}$ = 0.75;

	decreasing soil air temperature		0.06a	0.04a	0.07a	0.06a	0.04a	$P = 0.572$
	Soil-P4: Nighttime with lower soil air temperature	0:01-5:51	3.66 ± 0.05a	3.49 ± 0.04a	3.68 ± 0.06a	3.62 ± 0.06a	3.48 ± 0.05a	$F_{4,15} = 0.38$; $P = 0.819$
Day 6	Soil-P1: Morning and early afternoon with lower soil air temperature	6:01-11:41	3.44 ± 0.05a	3.24 ± 0.04a	3.43 ± 0.06a	3.40 ± 0.05a	3.23 ± 0.05a	$F_{4,15} = 0.49$; $P = 0.741$
	Soil-P2: Daytime and early nighttime with higher and increasing soil air temperature	11:51-21:01	3.77 ± 0.03a	3.67 ± 0.03a	3.77 ± 0.03a	3.81 ± 0.03a	3.63 ± 0.03a	$F_{4,15} = 0.48$; $P = 0.750$
	Soil-P3: Nighttime with higher and decreasing soil air temperature	21:11-23:51	3.92 ± 0.06a	3.84 ± 0.06a	3.95 ± 0.07a	3.93 ± 0.06a	3.78 ± 0.06a	$F_{4,15} = 0.34$; $P = 0.850$
	Soil-P4: Nighttime with lower soil air temperature	0:01-5:51	3.78 ± 0.04a	3.64 ± 0.05a	3.79 ± 0.05a	3.71 ± 0.05a	3.59 ± 0.04a	$F_{4,15} = 0.36$; $P = 0.830$