

Figure S1. Leaf area index simulations with and without frost damage for two winter wheat growing season at US-ARM site.

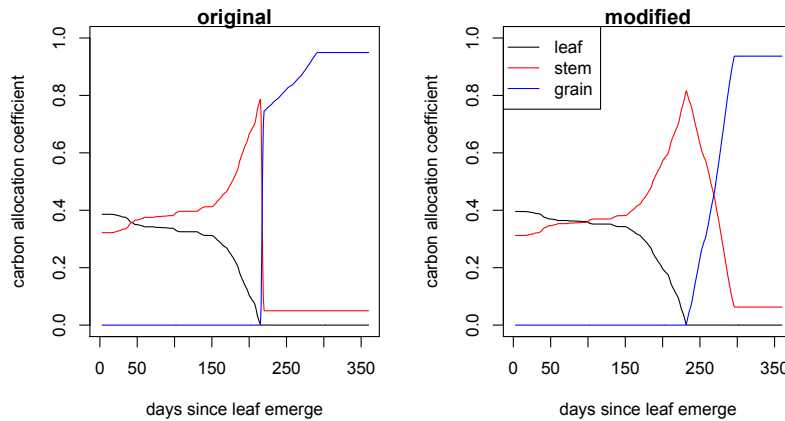


Figure S2. The original and modified winter wheat carbon allocation algorithms in CLM.

Table S1. The years for land surface variables to reach equilibrium at the four sites.

Land surface variables	Threshold	Years to reach equilibrium			
		US-ARM	US-PON	US-CRT	CAF-CT
Total ecosystem carbon (TOTECOSYSC)	1 (gC m <sup>-2</sup> )	260	32	760	34
Total soil organic carbon (TOTSOMC)	1 (gC m <sup>-2</sup> )	110	54	6	45
Total vegetation carbon (TOTVEGC)	1 (gC m <sup>-2</sup> )	240	156	137	4

Leaf area index (TLAI)	0.05 (m <sup>2</sup> m <sup>-2</sup> )	20	6	3	4
Gross primary production (GPP)	1(gC m <sup>-2</sup> )	30	26	12	30
Total water storage (TWS)	1 (mm)	40	10	15	301
Latent heat flux (EFLX_LH_TOT)	0.1 (W m <sup>-2</sup> )	30	8	5	6
Sensible heat flux (FSH)	0.1 (W m <sup>-2</sup> )	30	8	3	10
Winter wheat yield	0.1 (bu ac <sup>-1</sup> )	30	6	4	4

Table S2 Seasonal comparison of net radiation (W.m<sup>-2</sup>), latent heat flux (W.m<sup>-2</sup>), sensible heat flux (W.m<sup>-2</sup>), and net ecosystem exchange (umol.m<sup>-2</sup>.s<sup>-1</sup>) between observations and simulations across the four sites.

	Net radiation (W.m <sup>-2</sup> )				Latent heat flux (W.m <sup>-2</sup> )				Sensible heat flux (W.m <sup>-2</sup> )				NEE (umol.m <sup>-2</sup> .s <sup>-1</sup> )			
	Bias		RMSE		Bias		RMSE		Bias		RMSE		Bias		RMSE	
US-ARM																
ALL	-1.47	-4.6	4.71	7.95	4.83	2.77	9.64	12.67	-7.16	-7.77	11.19	13.72	1.92	2.36	2.21	2.7
DJF	-4.94	-12.81	4.96	13.26	-2.87	-1.32	2.98	5.8	-7.08	-12.91	7.58	13.46	1.44	1.66	1.44	1.66
MAM	2.24	-2.17	3.87	3.71	-0.53	-13.62	7.47	14.54	2.19	7.61	8.17	12.2	0.98	4.19	1.78	4.42
JJA	-1.33	-1	6.14	6.47	11.84	13.92	12.14	14.2	-13.93	-15.12	15.98	16.89	2.72	1.47	2.78	1.5
SON	-1.86	-2.4	3.38	4.64	10.87	12.09	12.63	14	-9.82	-10.65	11.03	11.74	2.54	2.13	2.55	2.14
US-PON																
ALL	-9.4	-17.44	16.1	23.67	3.27	-5.5	24.08	28.88	-7.84	-7.94	21.69	22.51				
DJF	-25.35	-37.97	26.59	39.88	-15.98	-19.95	16.58	21.36	-4.6	-13.39	9.09	15.78				
MAM	-0.68	-16.22	8.67	18.4	-9.18	-34.98	10.55	35.86	11.34	16.96	12.43	20.89				
JJA	3.52	1.39	3.83	3.44	40.99	37.46	43.79	39.41	-38.66	-35.71	40.45	36.47				
SON	-15.09	-16.97	15.48	17.33	-2.77	-4.55	3.94	6.43	0.56	0.37	2.85	3.44				
US-CRT																
ALL	-10.54	-17.43	17.66	21.33	-20.75	-24.18	23.82	32.49	23.28	19.86	29.03	28.1	1.97	2.65	2.88	4.4
DJF	4.77	-4.94	4.83	7.82	-11.68	-14.07	11.72	14.11	27.79	21.99	27.81	22.55	0.74	0.75	1.09	1.05
MAM	-5.75	-18.83	7.46	19.4	-21.43	-34.81	24.61	38.34	33.37	31.07	39.22	40.22	3.06	5.9	4.57	7.52
JJA	-27.09	-31.46	29.67	32.05	-28.34	-33.56	32.24	40.83	9.66	11.01	23.11	24.92	1.61	1.7	1.67	3.67
SON	-14.09	-14.48	16.97	18.82	-21.55	-14.27	22.1	29.76	22.3	15.34	22.92	20.32	2.47	2.26	2.88	2.54
CAF-CT																
ALL	-1.33	-9.53	13.28	13.43	-20.9	-20.33	25.74	24.83	10.83	1.45	29.08	16	-0.24	-0.26	0.32	0.31
DJF	-15.47	-17.24	16.43	18.28	-17.01	-17.48	17.2	17.68	-4.32	-4.68	7.49	7.62	2.06	4.21	2.71	5.13
MAM	7.27	-5.25	13.96	13.83	-29.91	-34.15	31.13	34.6	17.44	4.73	34.63	24.68	2.67	3.17	3.75	4.03
JJA	7.52	-10.84	14.13	12.33	-28.51	-23.2	35.48	28.8	33.59	9.7	45.89	17.98	1.17	1.18	1.3	1.26
SON	-4.64	-4.79	6.4	6.6	-8.17	-6.5	11.26	11.26	-3.4	-3.97	4.67	5.8	1.42	2.08	2.41	3.32