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A new temperature–photoperiod coupled phenology module in LPJ-GUESS model v4.1: optimizing estimation of terrestrial carbon and water processes

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Supplementary information

Figure S1 vegetation phenology based on remote sensing. (a) Spring phenology, (b) autumn phenology, (c) the change trend of spring phenology (SOS), and (d) the change trend of autumn phenology. The dots represent regions with significant change trend.

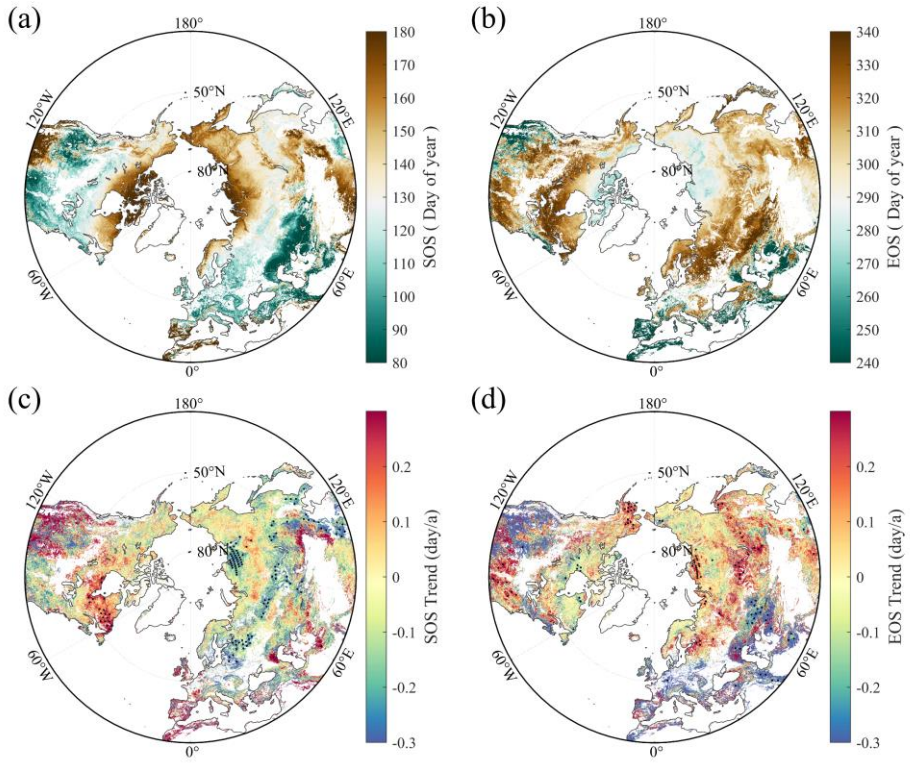

Figure S2 Plant function type fraction at 0.5° spatial resolution. (a) IBS, (b) TeBS, (c) BNS and (d) Shrubs.

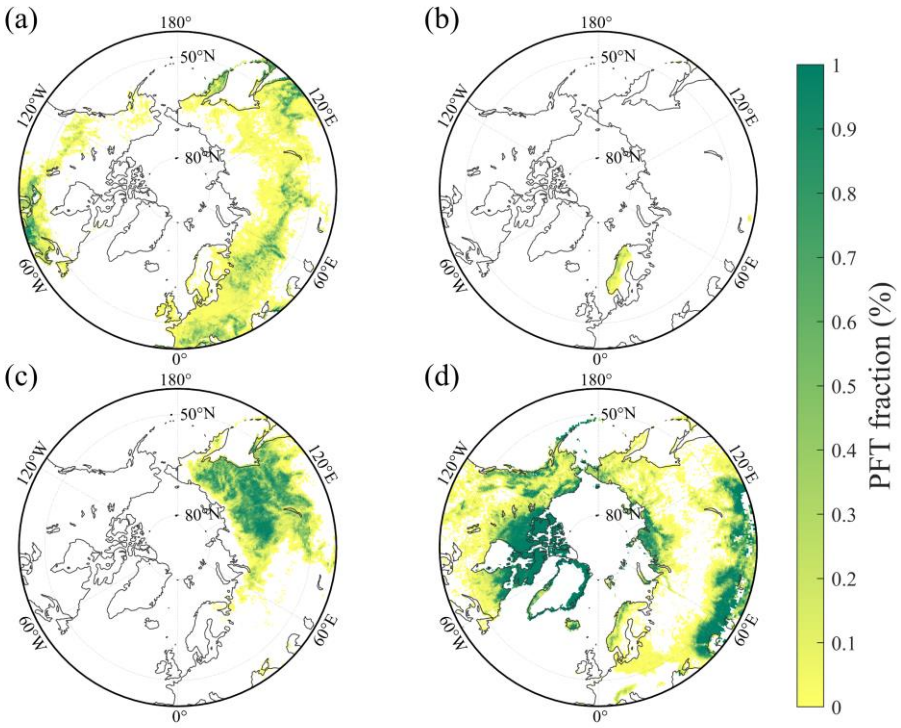

Figure S3 Potential nature plant distribution simulated by LPJ-GUESS during 1979-2015. (a) Simulation with original phenological module, (b) simulation with extended phenological module.

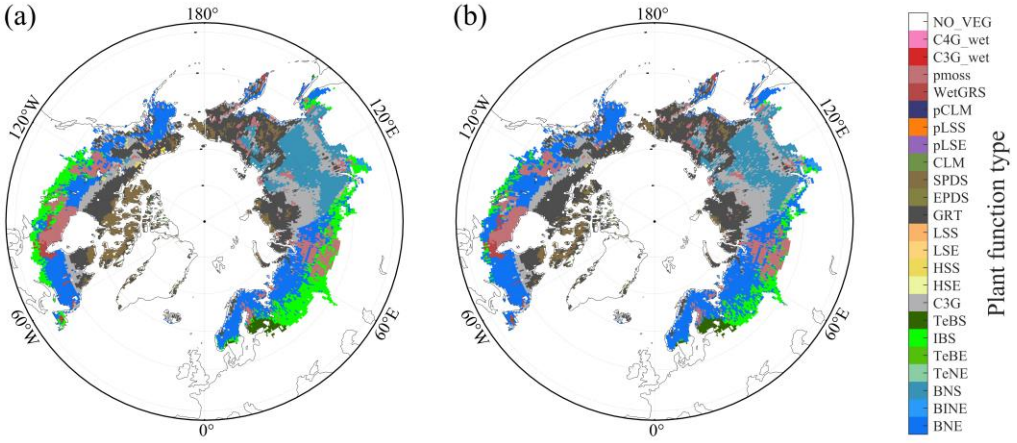

Figure S4 Daily leaf area index simulation performance of LPJ-GUESS model using original and extended phenological module.

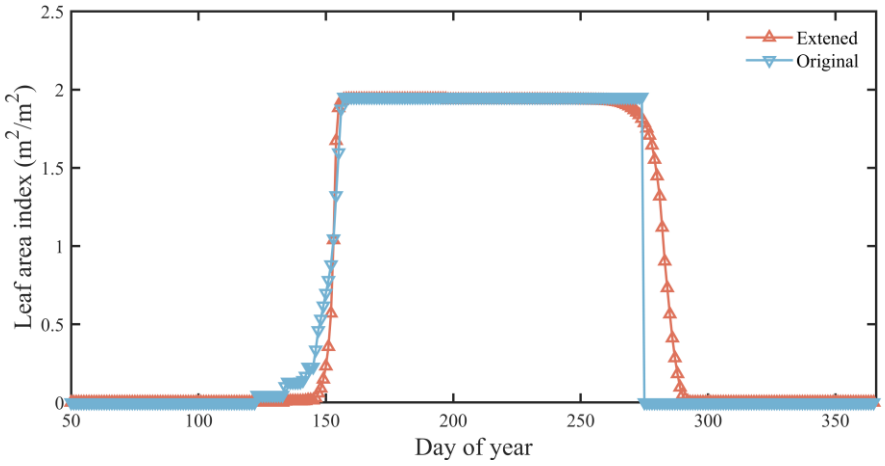

Figure S5 Frequency distributions of Spring (March to May) and Autumn (August to November) gross primary productivity (GPP) of LPJ-GUESS simulation and VPM product. (a-c) Spring GPP for BNS, IBS&TeBS and Shrubs dominant regions. (d-f) Autumn GPP for BNS, IBS&TeBS and Shrubs dominant regions.

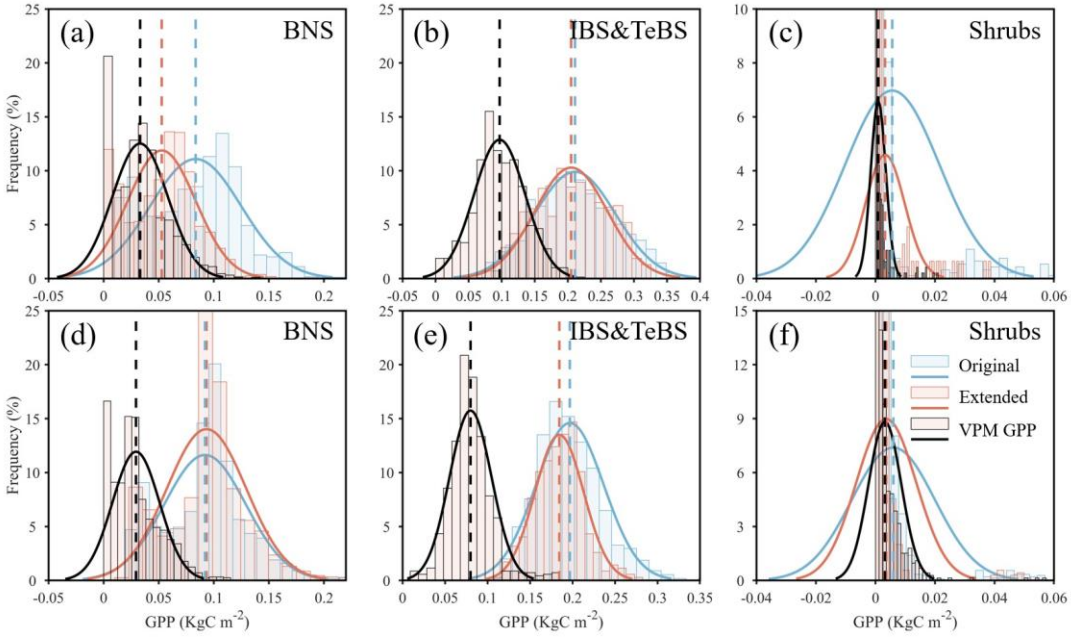

Figure S6 Spatial distributions of Spring (March to May) and Autumn (August to November) gross primary productivity (GPP) of LPJ-GUESS simulation and VPM GPP data. (a-c) Spring GPP with original, extended LPJ-GUESS and VPM data. (d-f) Autumn GPP with original, extended LPJ-GUESS and VPM data.

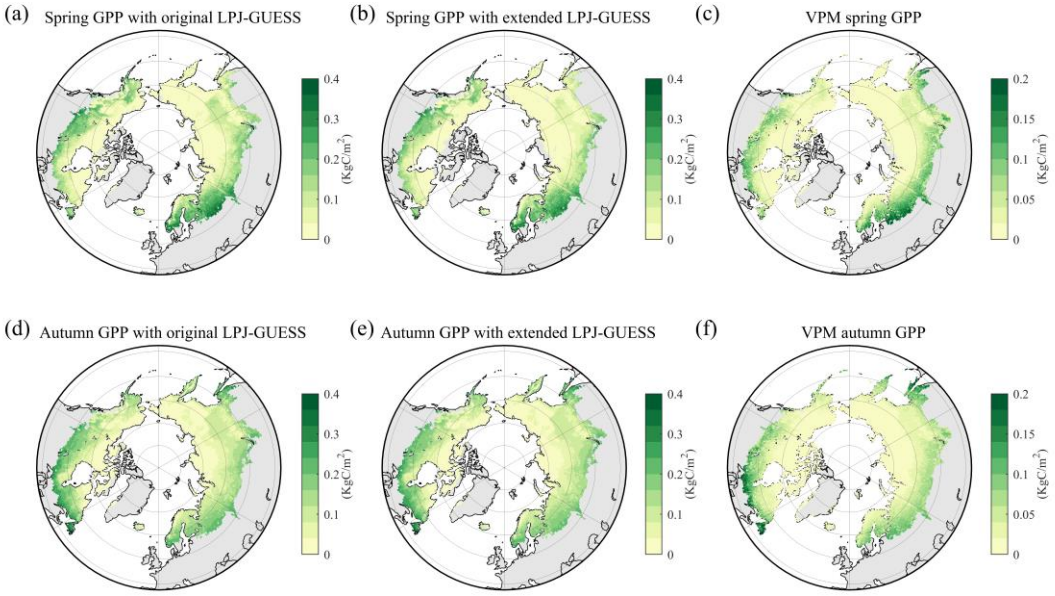

Figure S7 Spatial distributions of Spring (March to May) and Autumn (August to November) actual evapotranspiration (ART) of LPJ-GUESS simulation and REA ET data. (a-c) Spring AET with original, extended LPJ-GUESS and REA ET data. (d-f) Autumn AET with original, extended LPJ-GUESS and REA ET data.

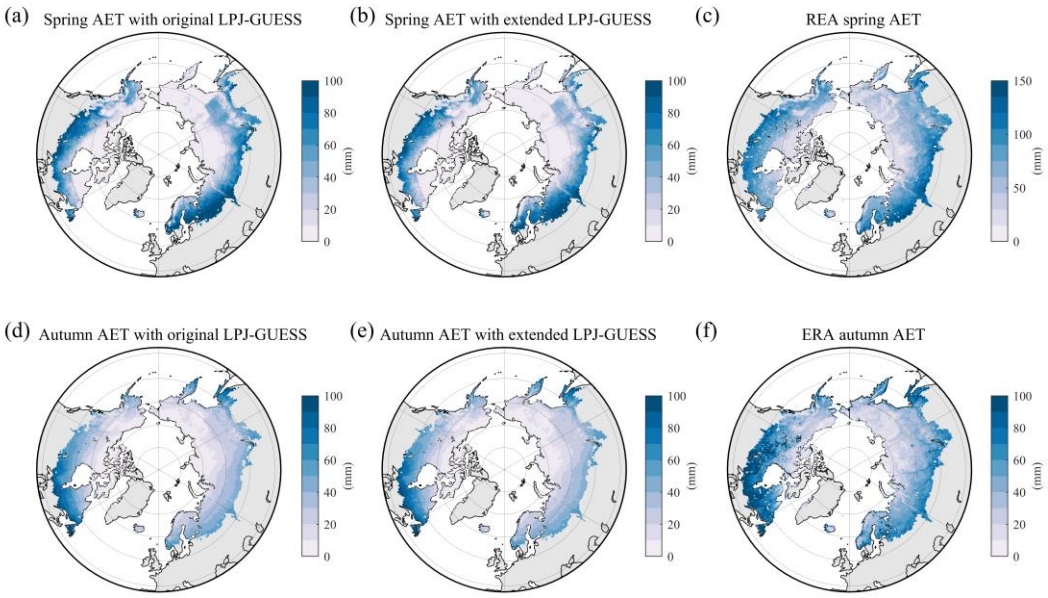

Table S1 DORMPHOT model parameters.

Plant function type	DLcrit	Dcrit	Ccrit	Fcrit	aD	bD	aC	cC	dF	gT	hDL
Range	[0,24]	[0,100]	[0,200]	[0,200]	[-1,1]	[-30,30]	[-1,1]	[-30,30]	[-1,1]	[0,30]	[0,30]
BNS	13.38	37.03	147.45	14.38	0.02	-11.84	-0.18	14.43	-0.28	7.86	17.57
IBS&TeBS	17.37	49.57	133.08	27.78	-0.05	-7.00	-0.11	10.62	-0.40	19.53	16.45
Shrubs	10.74	90.11	107.31	21.20	0.31	10.71	-0.36	-6.12	-0.26	17.38	16.40

BNS, boreal needle leaved summergreen tree, IBS, Shade-intolerant broadleaved summergreen tree, TeBS, shade-tolerant temperate broadleaved summergreen tree and Shrubs, summergreen shrubs plant function types.

Table S2 DM model parameters.

Plant function type	Tb	Pstart	Ycrit	x	y	porn
Range	[-40,40]	[0,24]	[0,50000]	[-3,3]	[-3,3]	0,1
BNS	22.21	22.24	5365.79	2.15	3.09	0
IBS&TeBS	39.12	16.42	8015.66	1.29	0.53	1
Shrubs	13.20	19.76	1380.31	1.59	1.03	0

BNS, boreal needle leaved summergreen tree, IBS, Shade-intolerant broadleaved summergreen tree, TeBS, shade-tolerant temperate broadleaved summergreen tree and Shrubs, summergreen shrubs plant function types).

Table S3 Model performance of parameterized original phenological module in LPJ-GUESS.

Plant function	Parameters			Internal calibration			External calibration		
type	a	b	k	R^2	NSE	RMSE	R^2	NSE	RMSE
BNS				0.52	0.35	9.07	0.50	0.29	9.64
IBS&TeBS	0.00	1515.08	0.021	0.41	0.36	11.85	0.41	0.33	12.03
Shrub				0.42	0.31	12.61	0.44	0.27	13.06
BNS	0.00	1649.60	0.024	0.50	0.42	8.63	0.50	0.40	8.91
IBS&TeBS	0.00	105.62	0.005	0.56	0.44	11.02	0.54	0.37	11.61
Shrub	0.00	1657.27	0.018	0.40	0.36	12.11	0.41	0.33	12.49

R^2, coefficient of determination, NSE, Nash–Sutcliffe Efficiency, RMSE, Root mean square error. BNS, boreal needle leaved summergreen tree, IBS, Shade-intolerant broadleaved summergreen tree, TeBS, shade-tolerant temperate broadleaved summergreen tree and Shrubs, summergreen shrubs plant function types. As with Sykes et al. (1996), the parameter a is fixed to 0.

Reference

Sykes, M. T., Prentice, I. C., and Cramer, W.: A bioclimatic model for the potential distributions of north European tree species under present and future climates, J. Biogeogr., 203-233, 1996.