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Applying double cropping and interactive irrigation in the North China Plain using WRF4.5

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Supplementary

Table S1. Parameter setting for spring maize and summer maize.

	Same as the parameter for one-year corn from X. Liu et al. (2016)
	Same as the parameter for one-year corn from Z. Zhang et al. (2020)
	Same as the parameter for spring wheat from Z. Zhang et al. (2023)
	Based on winter wheat study from Y. Zhang et al. (1991)
	Recalibrated with the station/satellite data

Parameter	Maize		Wheat	Physical meaning
	Spring	Summer	Winter	
GDDTBASE	10		0	Base temperature for GDD accumulation
GDDTCUT	30		30	Upper temperature for GDD accumulation
GDDS1	50		150	GDD from seeding to emergence
GDDS2	625		790	GDD from seeding to initial vegetative
GDDS3	1000		1190	GDD from seeding to post vegetative
GDDS4	1103		1600	GDD from seeding to initial reproductive
GDDS5	1555		2010	GDD from seeding to physical maturity
C3PSN	0		1	Indicator for C3 plant (1) or C4 plant (0)
KC25	30		30	CO_2 Michaelis-Menten constant at 25 °C
AKC	2.1		2.1	Q10* base for KC25
KO25	3.E4		3.E4	CO_2 Michaelis-Menten constant at 25 °C
AKO	1.2		1.2	Q10* base for KO25
AVCMX	2.4		1.5	Q10* base for VCMX25
VCMX25	60		80	Maximum rate of carboxylation at 25 °C
BP	4.E3		1.E4	Minimum leaf conductance
MP	4		9	Slope of conductance-to-photosynthesis
QE25 (1)	0.08		0.12	Quantum efficiency at 25 °C
Q10MR	2.0		2.0	Q10* base for maintenance respiration
LEFREEZ	268		268	characteristic T for leaf freezing
DILE_FC_S5	0.5		0.5	Coefficient for temperature leaf stress death
DILE_FC_S6	0.5		0.5	
DILE_FW_S5	0.2		0.2	Coefficient for water leaf stress death
DILE_FW_S6	0.2		0.2	
FRA_GR	0.2		0.2	Fraction of growth respiration
LF_OVRC_S5	0.2		0.05	Fraction of leaf turnover
LF_OVRC_S6	0.3		0.05	
ST_OVRC_S5	0.12		0.05	Fraction of stem turnover
ST_OVRC_S6	0.06		0.05	
RT_OVRC_S5	0.12		0.12	Fraction of root turnover
RT_OVRC_S6	0.06		0.06	

LFMR25	0.8		0.8	Leaf maintenance respiration at 25 °C
STMR25	0.05		0	Stem maintenance respiration at 25 °C
RTMR25	0.05		0	Root maintenance respiration at 25 °C
LFPT_S3	0.36	0.4	0.45	Fraction of carbohydrate flux to leaf
LFPT_S4	0.2	0.3	0.55	
LFPT_S5	0.1		0	
LFPT_S6	0.1		0	
STPT_S3	0.24	0.2	0.4	Fraction of carbohydrate flux to stem
STPT_S4	0.5	0.2	0.45	
STPT_S5	0.4	0.3	0.4	
STPT_S6	0	0.2	0.3	
RTPT_S3	0.4	0.3	0.15	Fraction of carbohydrate flux to root
RTPT_S4	0.3	0.5	0.0	
RTPT_S5	0.2	0.2	0.1	
RTPT_S6	0.1	0	0.1	
GRAINPT_S5	0.4	0.4	0.5	Fraction of carbohydrate flux to grain
GRAINPT_S6	0.8	0.7	0.6	
LFCT_S6 [(2)]	0		0.0005	Carbohydrate translocation from leaf to grain
STCT_S6 [(2)]	0		0.001	Carbohydrate translocation from stem to grain
BIO2LAI [(3)]	0.023	0.020	0.008	Leaf area per living leaf biomass

*Q10 means the rate increases by a 10°C temperature increases

[(1)] The QE25 parameter is increased following the removal of the great-overestimated and non-water-sensitive assumption 'FVEG=0.95'. This removal significantly decreases the radiation intercepted by vegetation, consequently imposing light limitations when calculating photosynthesis. Since the crop model adopts the same photosynthesis function as other non-crop vegetation in the Noah-MP, for simplicity, we opt to raise the crop quantum efficiency to achieve higher photosynthesis without affecting other vegetation types.

[(2)] Carbohydrate translocation from leaf and stem to grain, which typically occurs during the reproductive stages, has been sometimes overlooked. However, we found it is necessary to include it when predicting the wheat yield in the highly productive NCP (Huang et al., 2020; Ma et al., 2006).

[(3)] The average station BIO2LAI is calculated to be 0.02 for maize and 0.01 for winter wheat approximately. However, the BIO2LAI varies a lot during different stages and different quadrats, which requires slight recalibration around that station value. The final 0.023 for spring maize is similar to the 0.025 calibrated by (Yu et al., 2022) in northeast China.

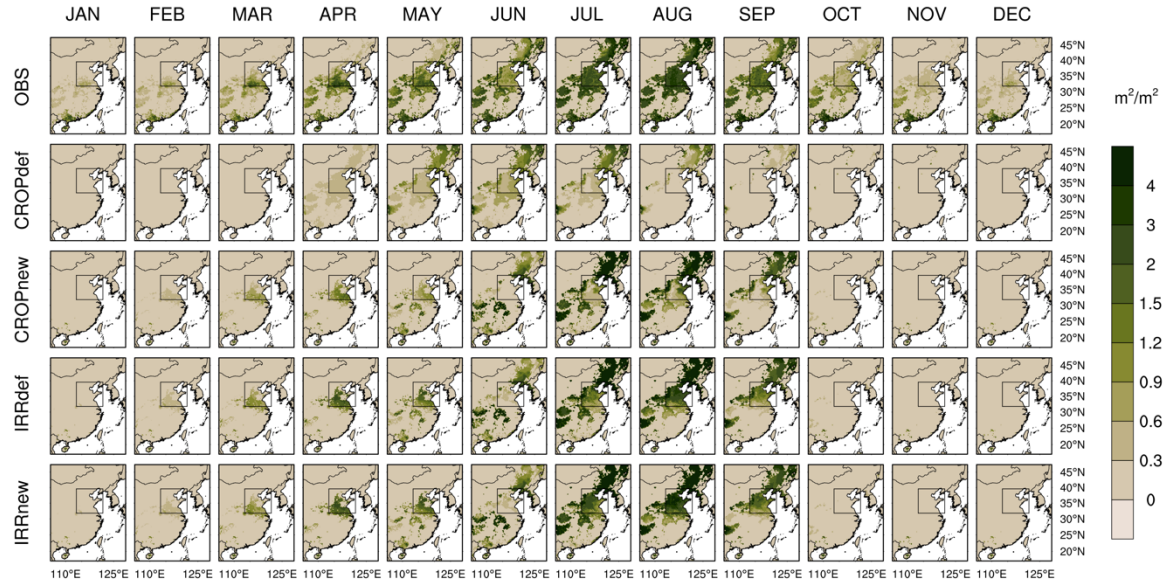

Figure S1. Monthly LAI pattern of the satellite observation, default crop model only, and after all modification and integration. This is an extended version of Fig. 8.

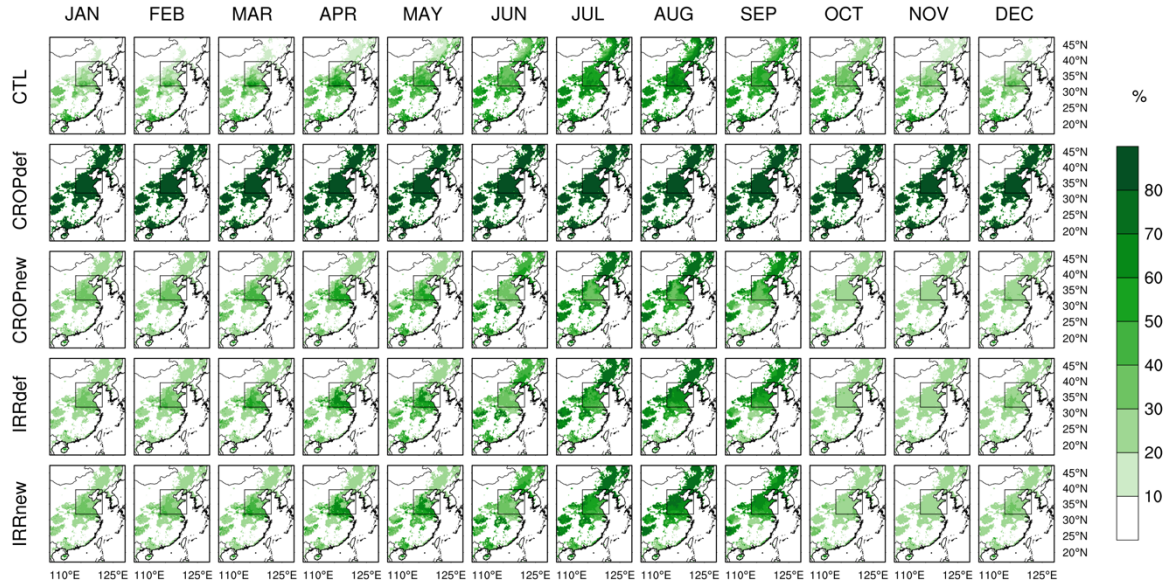

Figure S2. Similar to Fig. S1 but for FVEG. Notice that in the default crop model (CROPdef) all FVEG is fixed to 95%.