Supplementary Materials: Modeling Transpiration with Sun-Induced Chlorophyll Fluorescence Observations via Carbon-Water Coupling Methods

Table S1. Input and intermediate variables. AWS denotes the auto weather station. FAO indicates the computation methods of the variable is from http://www.fao.org.

Variables	Unit	Description	Source	Remarks
C_a	μmol/mol	Ambient CO_2 concentration	Observation	Eddy covariance
C_p	J/Kg/K	Specific heat of air	1013	FAO
E	W/m^2	Soil evaporation	$\frac{f\Delta(Rn - A_c)}{\Delta + \gamma}$	[1]
f	-	Soil evaporation constraint	$SM - SM_{min}/(SM_{max} - SM_{min})$	[2]
ga	m/s	Aerodynamic conductance	$\frac{1}{v/(u*)^2 + 6.2(u*)^{-2/3}}$	[3]
GPP_{ob}	$\mu mol/m^2/s$	Gross primary production	Separated from NEE observed by eddy covariance	-
LE	W/m^2	Latent heat	Observation	Eddy covariance
PAR	W/m^2	Photosynthetically active radiation	Observation	AWS
P	kPa	Air pressure	Observation	AWS
q_L	-	Fraction of open Photosynthesis II reaction centers	$\exp(-\beta\ PAR)$	This paper
Rh	-	Relative humidity	Observation	AWS
Rn	W/m^2	Net radiation	Observation	AWS
SIF	$mW/m^2/sr/nm$	Sun-induced chlorophyll fluorescence	Observation	-
SM	-	Soil moisture	Observation	Thermal dissipation probe
SZA	°	Sun zenith angle	Calculated by location and time (See Supplementary Codes)	[4]
Ta	°C	Air temperature	Observation	AWS
u^*	m/s	Friction Velocity	Observation	Eddy covariance
v	m/s	Wind speed	Observation	AWS
VPD	kPa	Vapor pressure deficit	$(100 - Rh)/100 \times 0.6108 \times \exp(17.27\ Ta/(Ta + 237.3))$	FAO
Δ	kPa/K	Slope of saturation vapor pressure curve	$(2503 \exp(17.27\ Ta/(Ta + 237.3)))/((Ta + 237.3)^2)$	FAO
γ	kPa/K	Psychrometric constant	$0.665 \times 0.001P$	FAO
λ	-	marginal water use efficiency	-	[5]
ρ	kg/m^3	Air density	$1.292 - 0.00428\ Ta$	FAO
Γ	μmol/mol	CO2 compensation point in the absence of mitochondrial	$36.9 + 1.18(Ta - 25) + 0.036(Ta - 25)^2$ for C3; 0 for C4	[6]
Ω_c	-	Probability of SIF photon escaping from the canopy	constant	[7]

Table S2. Parameters needed to be calibrated.

	Parameter	Lower	Upper	Reference
Linear model	K1	5	50	[8,9]
	K2	3	50	[10]
WUE method	K1	5	50	[8,9]
	K3	3	30	This paper
	K4	0.1	1	[11]
Conductance method (C4)	β	0	0.001	This paper; [12]
	a	10	300	This paper
	m	2.5	8.8	[13]
Conductance method (C3)	β	0	0.01	This paper; [12]
	a	10	300	This paper
	λ	10	2000	[5,6]

Table S3. Coefficient of determination (R^2) and root mean square error (RMSE) of different methods estimating T by SIF at different sites. Best values are marked with bold font.

		Reference	DM		HL		NR		HF	
			R^2	RMSE	R^2	RMSE	R^2	RMSE	R^2	RMSE
Hourly	T_{SLR}	T_{Zhou}	0.43	102.92	0.57	50.61	0.47	35.42	0.46	60.51
	T_{WUE}		0.53	98.00	0.55	53.26	**0.68**	**29.32**	0.49	**62.62**
	T_{gs}		**0.93**	**29.55**	**0.80**	**34.83**	0.54	34.30	**0.58**	67.76
	LE_{SLR}	LE	0.53	120.30	0.53	67.23	0.25	67.20	0.45	77.01
	LE_{WUE}		0.52	111.68	**0.55**	**67.16**	**0.37**	**63.66**	0.46	75.42
	LE_{gs}		**0.87**	**66.85**	0.41	77.69	**0.37**	63.79	**0.52**	**71.94**
Daily	T_{SLR}	T_{Zhou}	0.61	73.00	0.60	45.44	0.71	39.13	0.72	**37.12**
	T_{WUE}		0.63	73.65	0.49	53.92	**0.86**	24.83	0.76	48.94
	T_{gs}		**0.81**	**46.76**	**0.71**	**39.63**	0.75	**22.89**	**0.84**	51.91
	LE_{SLR}	LE	0.64	88.07	0.25	75.61	0.14	66.89	0.41	51.13
	LE_{WUE}		0.53	95.98	**0.54**	65.70	0.41	64.52	**0.73**	69.55
	LE_{gs}		**0.83**	**69.67**	0.40	**62.11**	**0.42**	**57.73**	0.63	**42.24**

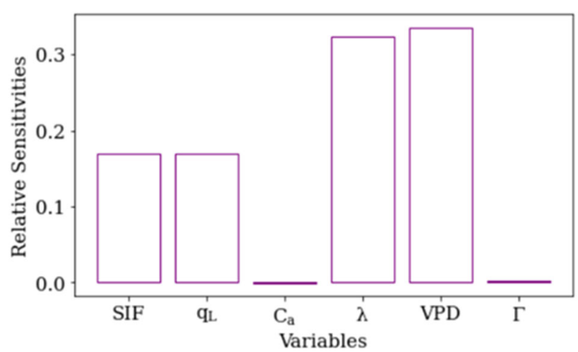

Figure S1. Sensitivity analysis of variables in the stomatal conductance method $\mathcal{F}$ of C3 plants. The height of the bars shows the relative sensitivities of different variables.

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