

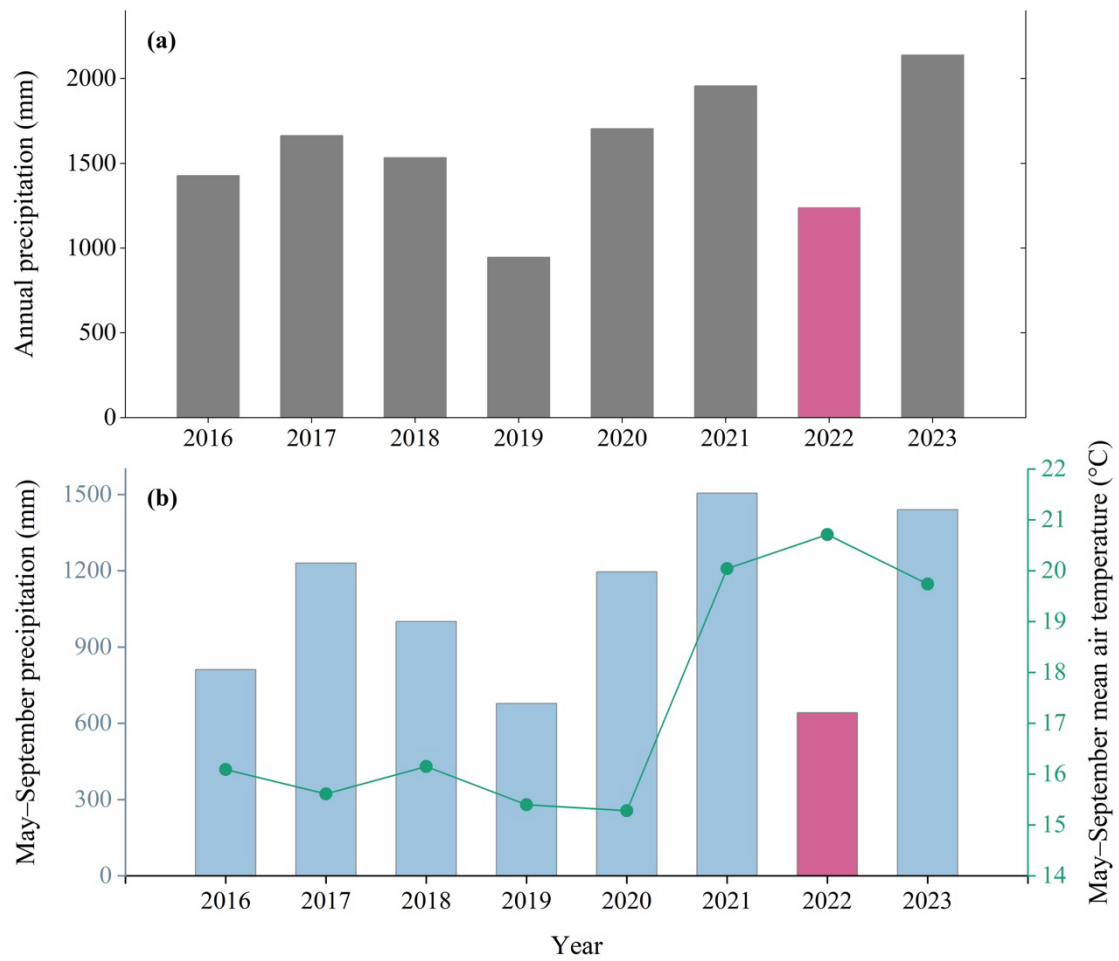


Figure S1. Multi-year meteorological context during 2016–2023 at the Dajiuahu peatland. (a) Annual precipitation. (b) Cumulative precipitation and mean air temperature during the May–September growing season. Pink bars indicate 2022. Because continuous observations began in August 2015, 2016 was the first complete year included in the multi-year meteorological comparison.

Table S1. Precipitation, WTD, SWC_10 cm and NEE during the Normal, Stressed and Recovery periods.

Variable	Unit	Normal	Stressed	Recovery
Precipitation	mm	1505.1	641.7	1440.1
WTD	cm	19.73 ± 5.18	31.15 ± 12.80	25.21 ± 6.32
SWC_10 cm	m ³ m ⁻³	0.584 ± 0.013	0.567 ± 0.104	0.575 ± 0.047
NEE	g C m ⁻²	-414.94	-32.55	-93.46

Note: Precipitation and NEE are cumulative values for each period. WTD and SWC_10 cm are reported as mean ± SD. Negative NEE values indicate CO₂ uptake by the ecosystem.

Table S2. Statistical comparisons of hydrological variables and CO₂ flux components among hydrological stages.

Variable	KW_H	KW_P	Holm P (N vs S)	Holm P (N vs R)	Holm P (S vs R)	Letters (N/S/R)
WTD	115.74	<0.001	<0.001	<0.001	0.002	a / c / b
SWC_10cm	6.41	0.041	0.382	0.038	0.21	a / ab / b
NEE	133.67	<0.001	<0.001	<0.001	0.048	a / c / b
GPP	124.99	<0.001	<0.001	<0.001	0.877	b / a / a
Reco	45.52	<0.001	<0.001	<0.001	0.002	a / b / c

Note: KW_H and KW_P denote the Kruskal–Wallis H statistic and its corresponding P value, respectively. Dunn's post hoc tests with Holm correction were used for pairwise comparisons when overall differences were significant. N, S and R denote Normal, Stressed and Recovery, respectively. Different lowercase letters indicate significant differences among periods at $P < 0.05$, whilst shared letters indicate no significant differences between groups.

Table S3. Cumulative NEE, GPP and Reco during the Normal, Stressed and Recovery periods.

Variable	Unit	Normal	Stressed	Recovery
NEE	g C m^{-2}	-414.94	-32.55	-93.46
GPP	g C m^{-2}	1337.17	732.03	750.52
Reco	g C m^{-2}	922.23	699.48	657.06

***Note:** Values represent cumulative CO₂ fluxes for each period. Negative NEE values indicate net CO₂ uptake, whereas positive NEE values indicate net CO₂ release. GPP and Reco are expressed as positive values.*

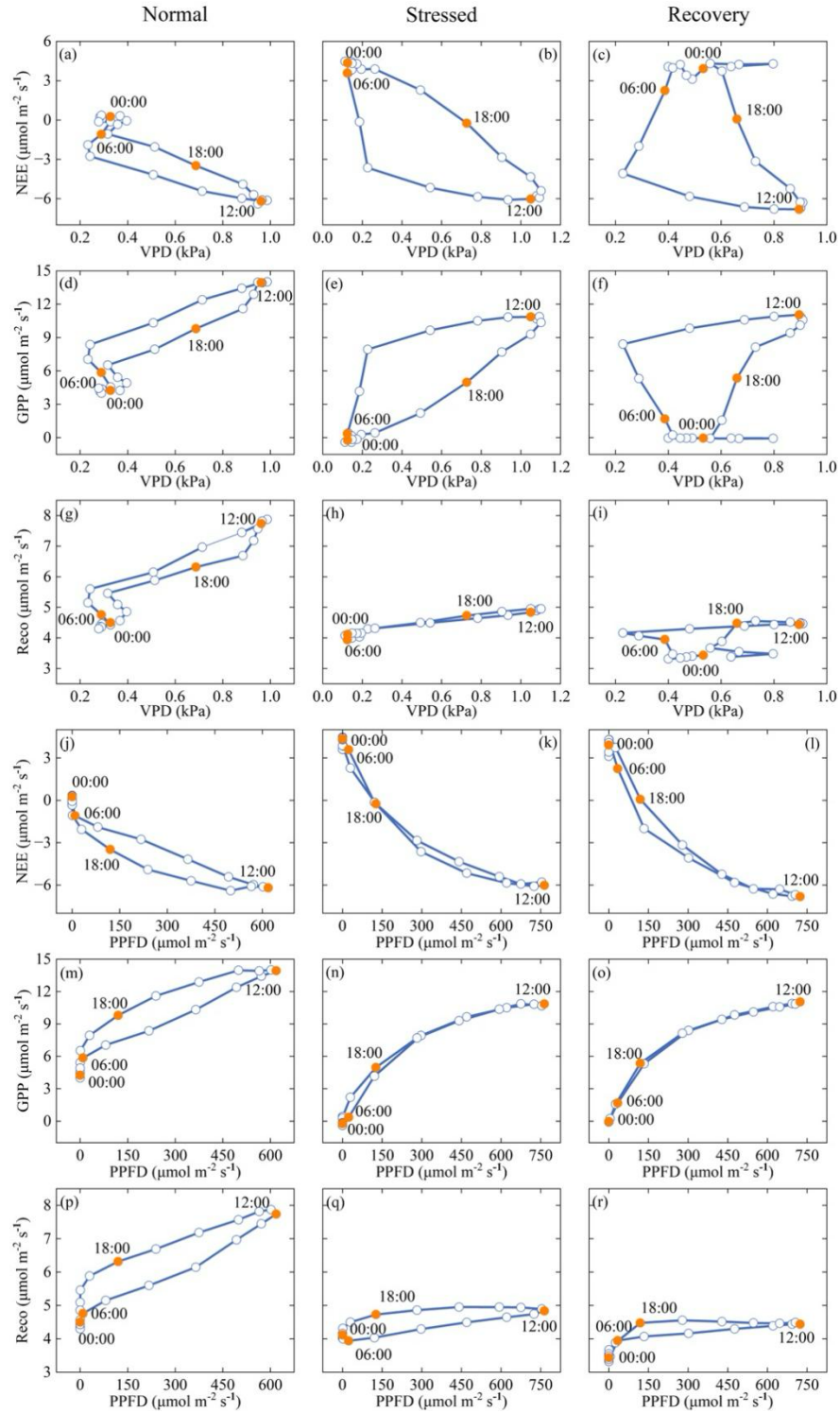


Figure S2. Diel hysteresis patterns between CO₂ flux components and atmospheric variables across the three hydrological stages. Panels (a–i) show relationships between vapor pressure deficit (VPD) and NEE, GPP and Reco, respectively; panels (j–r) show relationships between photosynthetic photon flux density (PPFD) and NEE, GPP and Reco, respectively. Trajectories were constructed

from 24 hourly mean values, connected chronologically, and shown in original units. Arrows indicate diel progression. Filled circles indicate representative time points (00:00, 06:00, 12:00 and 18:00).

Table S4. Normalized hysteresis areas between CO₂ flux components and atmospheric variables.

Variable pair	Normal	Stressed	Recovery
VPD-NEE	0.115	0.452	0.341
VPD-GPP	0.118	0.349	0.260
VPD-Reco	0.088	0.017	0.048
PPFD-NEE	0.083	0.021	0.051
PPFD-GPP	0.112	0.016	0.004
PPFD-Reco	0.149	0.103	0.050

***Note:** Normalized hysteresis areas were calculated after applying one shared min–max range to the pooled 24 hourly points across the Normal, Stressed and Recovery periods for each variable pair.*

Table S5. Comparison of lagged responses to hydrological variables between the 0-30 d and 0-60 d windows.

Variable pair	Period	0-30 d						0-60 d					
		raw lag (d)	raw ρ	raw p	detrended lag (d)	detrended ρ	detrended p	raw lag (d)	raw ρ	raw p	detrended lag (d)	detrended ρ	detrended p
WTD-NEE	Normal	3	-0.332	<0.001	0	-0.251	<0.01	3	-0.332	<0.001	0	-0.251	<0.01
	Stressed	4	0.391	<0.001	4	0.44	<0.001	4	0.391	<0.001	4	0.44	<0.001
	Recovery	0	0.3	<0.001	0	0.178	<0.05	0	0.3	<0.001	0	0.178	<0.05
SWC-NEE	Normal	2	-0.033	ns	0	0.087	ns	2	-0.033	ns	0	0.087	ns
	Stressed	12	-0.347	<0.001	4	-0.31	<0.001	12	-0.347	<0.001	4	-0.31	<0.001
	Recovery	0	-0.245	<0.01	1	0.041	ns	0	-0.245	<0.01	46	0.278	<0.05
WTD-GPP	Normal	3	0.5	<0.001	0	0.334	<0.001	3	0.5	<0.001	0	0.334	<0.001
	Stressed	0	0.327	<0.001	0	0.355	<0.001	0	0.327	<0.001	0	0.355	<0.001
	Recovery	1	0.196	<0.05	0	0.251	<0.01	1	0.196	<0.05	0	0.251	<0.01
SWC-GPP	Normal	2	0.193	<0.05	2	0.098	ns	2	0.193	<0.05	2	0.098	ns
	Stressed	0	-0.325	<0.001	0	-0.285	<0.001	0	-0.325	<0.001	0	-0.285	<0.001
	Recovery	5	-0.311	<0.001	0	-0.53	<0.001	5	-0.311	<0.001	0	-0.53	<0.001
WTD-Reco	Normal	0	0.448	<0.001	0	0.318	<0.001	0	0.448	<0.001	0	0.318	<0.001
	Stressed	0	0.63	<0.001	0	0.638	<0.001	0	0.63	<0.001	0	0.638	<0.001
	Recovery	4	0.468	<0.001	2	0.434	<0.001	4	0.468	<0.001	2	0.434	<0.001
SWC-Reco	Normal	2	0.219	<0.01	2	0.176	<0.05	2	0.219	<0.01	2	0.176	<0.05
	Stressed	0	-0.542	<0.001	0	-0.48	<0.001	0	-0.542	<0.001	0	-0.48	<0.001
	Recovery	0	-0.381	<0.001	0	-0.359	<0.001	0	-0.381	<0.001	0	-0.359	<0.001

Note: The 0–60 d window was used as a sensitivity analysis to evaluate whether peak lag times were stable under an extended lag window. Both raw and detrended results are shown. Positive lag values indicate that CO₂ flux components responded after changes in environmental variables. Detrended results were used as the main basis for

interpretation. p -values are presented as significance classes (<0.001 , <0.01 , <0.05 , ns), where ns indicates $p \geq 0.05$.

Table S6. Comparison of lagged responses to temperature variables between the 0-30 d and 0-60 d windows.

Variable pair	Period	0–30 d						0–60 d					
		raw lag (d)	raw ρ	raw p	detrended lag (d)	detrended ρ	detrended p	raw lag (d)	raw ρ	raw p	detrended lag (d)	detrended ρ	detrended p
Ta-NEE	Normal	0	-0.037	ns	0	-0.201	<0.05	33	-0.25	<0.05	0	-0.201	<0.05
	Stressed	12	0.397	<0.001	16	0.249	<0.01	12	0.397	<0.001	16	0.249	<0.01
	Recovery	0	0.059	ns	0	-0.138	ns	0	0.059	ns	48	-0.326	<0.05
Ts-NEE	Normal	0	-0.287	<0.001	0	-0.433	<0.001	0	-0.287	<0.001	0	-0.433	<0.001
	Stressed	30	0.672	<0.001	16	0.422	<0.001	31	0.702	<0.001	16	0.422	<0.001
	Recovery	0	0.294	<0.001	13	0.178	<0.05	0	0.294	<0.001	13	0.178	<0.05
Ta-GPP	Normal	6	-0.232	<0.01	30	0.341	<0.001	6	-0.232	<0.01	33	0.385	<0.001
	Stressed	1	0.43	<0.001	1	0.575	<0.001	1	0.43	<0.001	1	0.575	<0.001
	Recovery	23	-0.191	<0.05	14	-0.183	<0.05	23	-0.191	<0.05	14	-0.183	<0.05
Ts-GPP	Normal	14	-0.242	<0.01	30	0.254	<0.05	14	-0.242	<0.01	32	0.286	<0.01
	Stressed	0	0.265	<0.001	0	0.601	<0.001	0	0.265	<0.001	0	0.601	<0.001
	Recovery	1	0.436	<0.001	0	0.618	<0.001	1	0.436	<0.001	0	0.618	<0.001
Ta-Reco	Normal	7	-0.266	<0.01	30	0.295	<0.01	7	-0.266	<0.01	33	0.317	<0.01
	Stressed	3	0.684	<0.001	1	0.689	<0.001	3	0.684	<0.001	1	0.689	<0.001
	Recovery	30	0.23	<0.05	0	-0.012	ns	31	0.237	<0.05	0	-0.012	ns
Ts-Reco	Normal	7	-0.324	<0.001	7	-0.225	<0.01	7	-0.324	<0.001	7	-0.225	<0.01
	Stressed	5	0.561	<0.001	0	0.723	<0.001	5	0.561	<0.001	0	0.723	<0.001
	Recovery	2	0.492	<0.001	1	0.444	<0.001	2	0.492	<0.001	1	0.444	<0.001

Note: The 0–60 d window was used as a sensitivity analysis to evaluate whether peak lag times were stable under an extended lag window. Both raw and detrended results are shown. Positive lag values indicate that CO₂ flux components responded after changes in environmental variables. Detrended results were used as the main basis for

interpretation. p -values are presented as significance classes (<0.001 , <0.01 , <0.05 , ns), where ns indicates $p \geq 0.05$.