Supporting Information for

Eddy covariance data reveal that a small freshwater reservoir emits a substantial amount of carbon dioxide and methane

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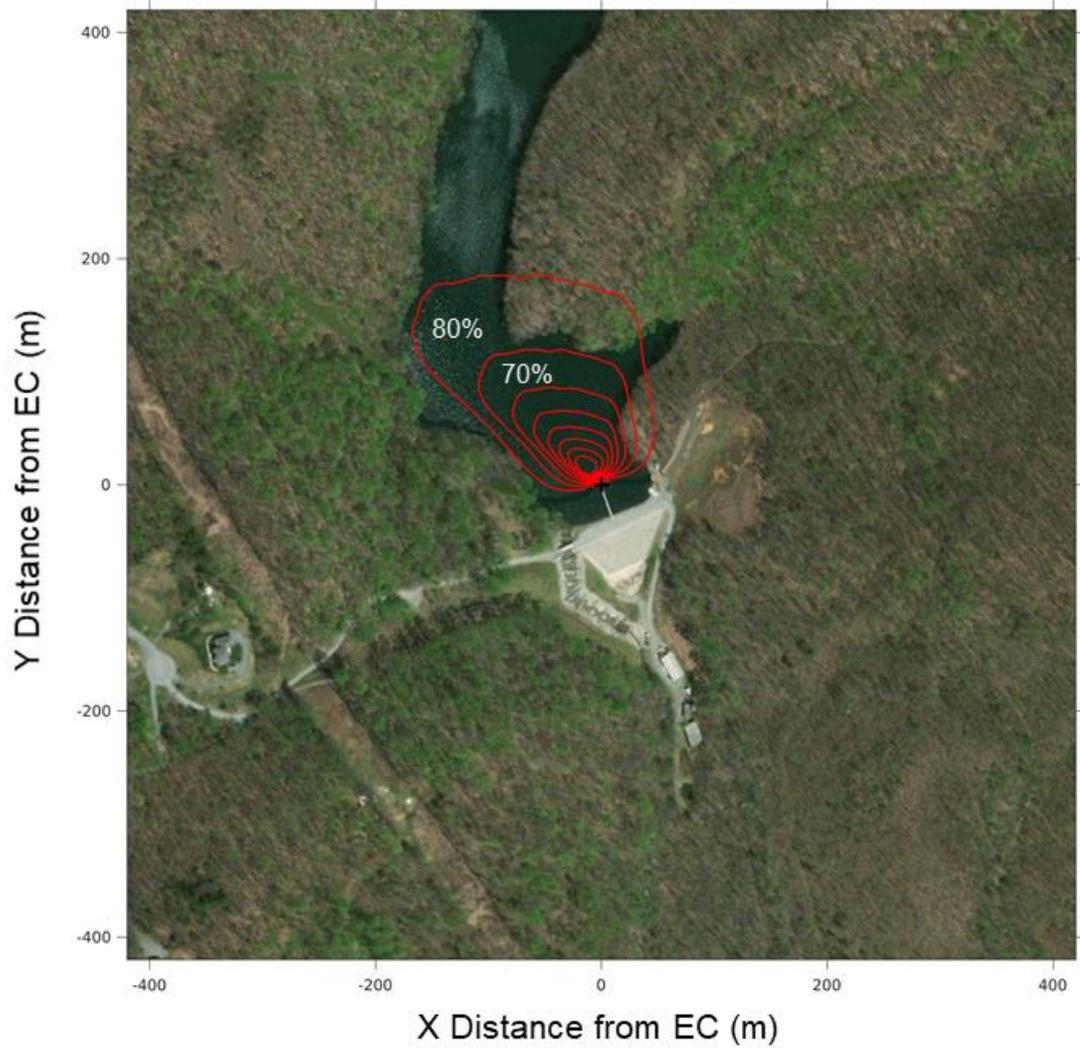
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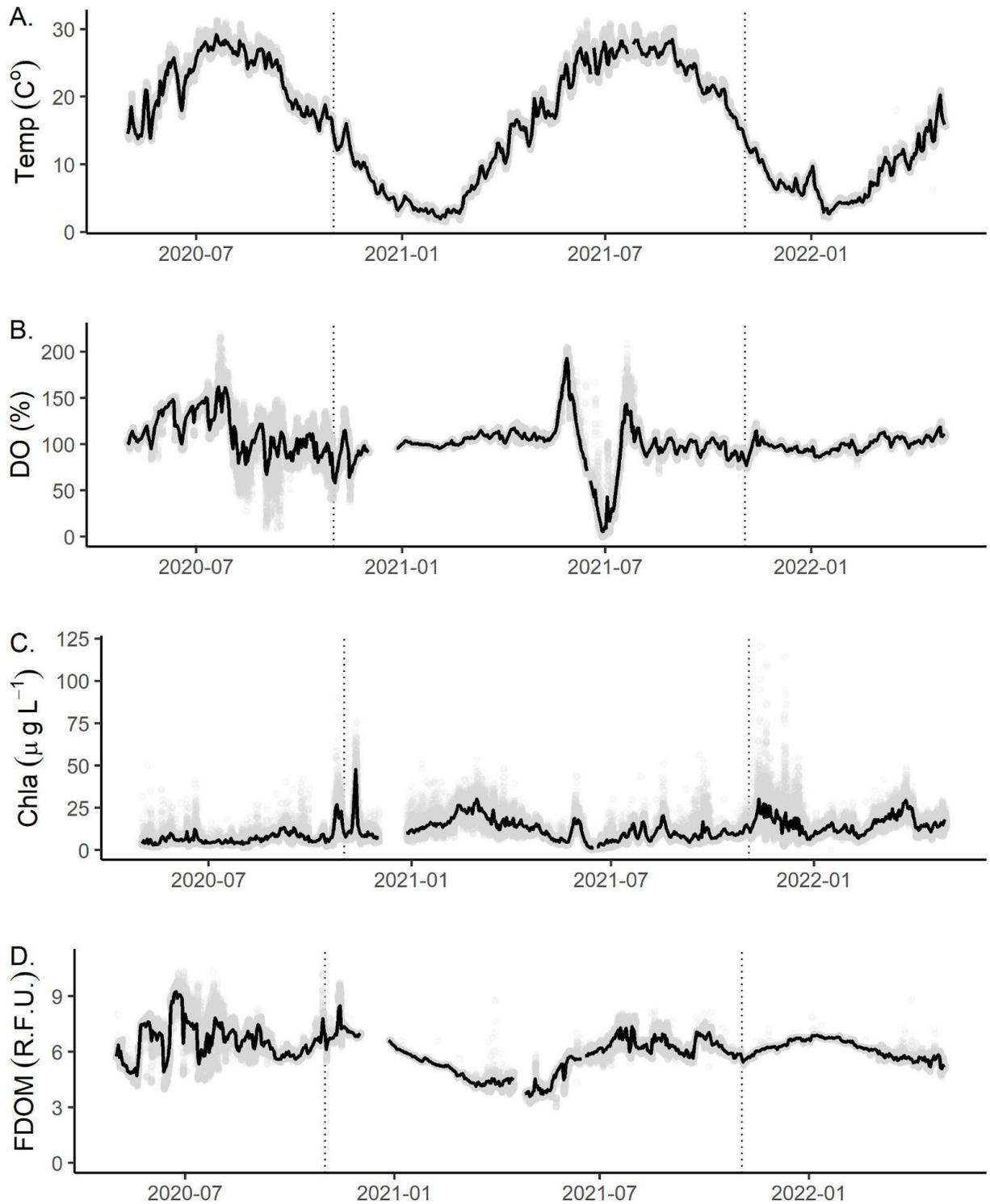
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measured at 1.6 m; and D. fluorescent dissolved organic matter (fDOM, Relative Fluorescence Units, RFU) measured at 1.6 m. Solid black lines represent the daily mean while the light grey points represent individual measurements made every 15 minutes for inflow and every 10 minutes for all other variables. The dashed vertical black line indicates reservoir fall turnover for both years.
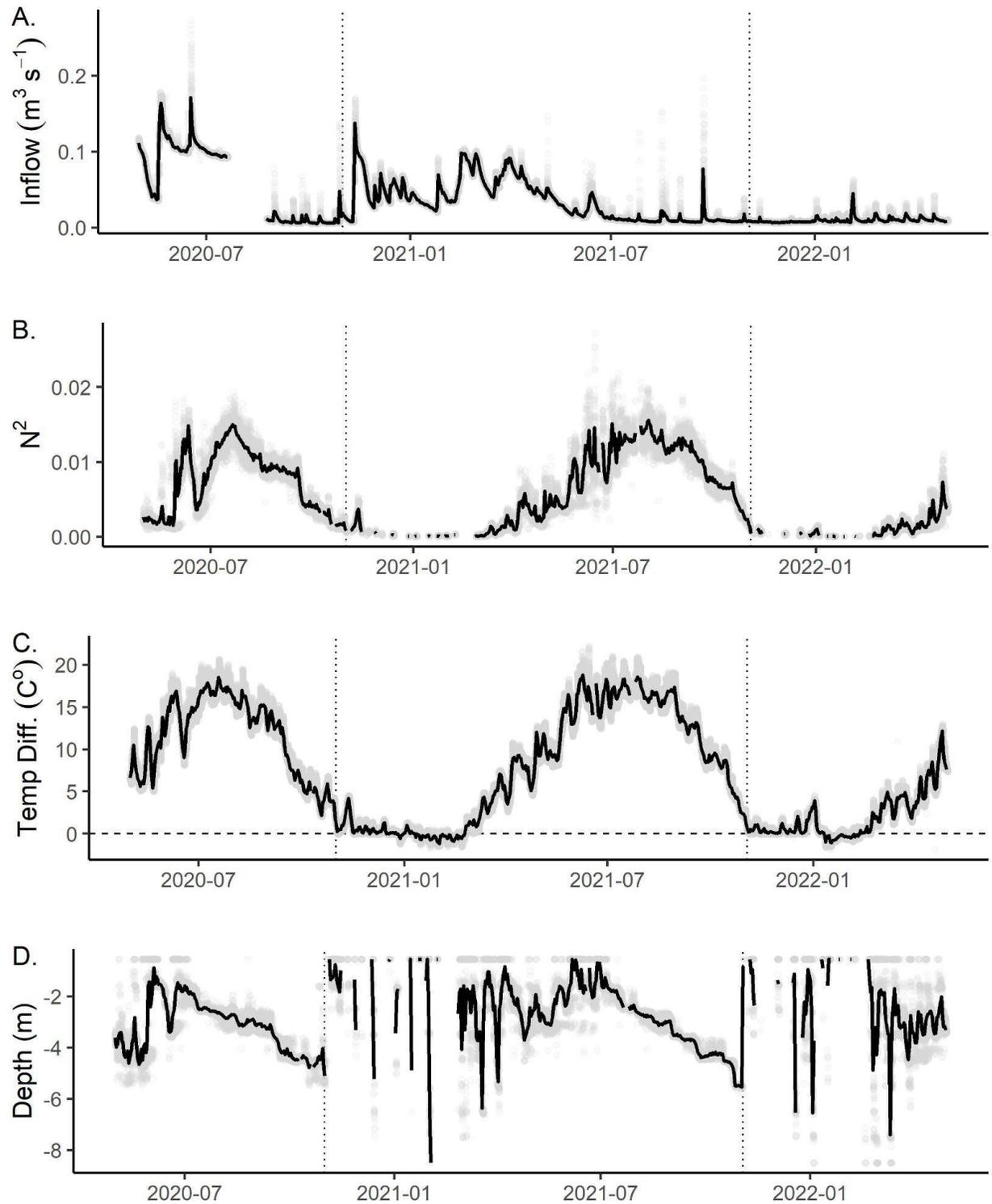
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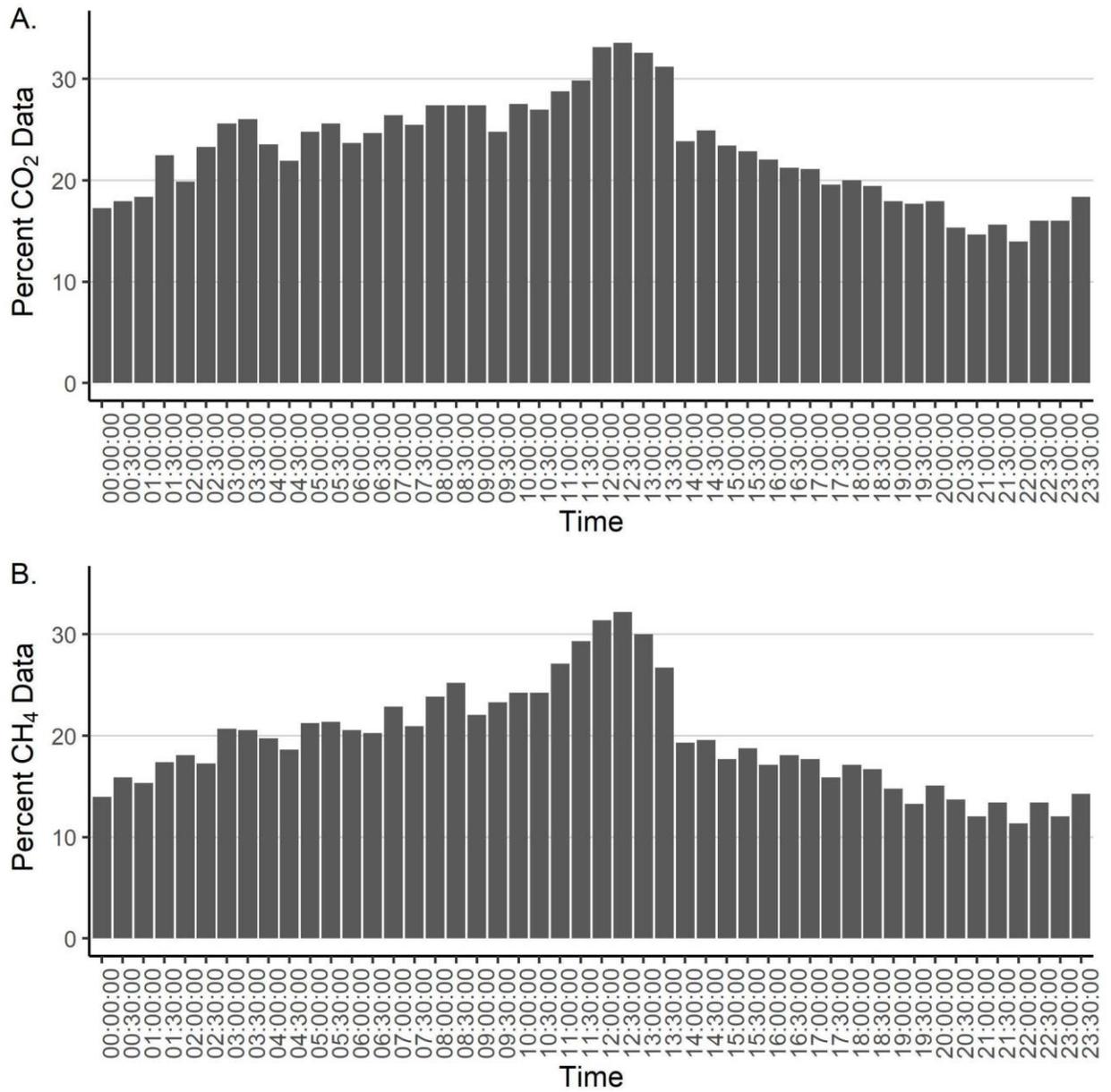
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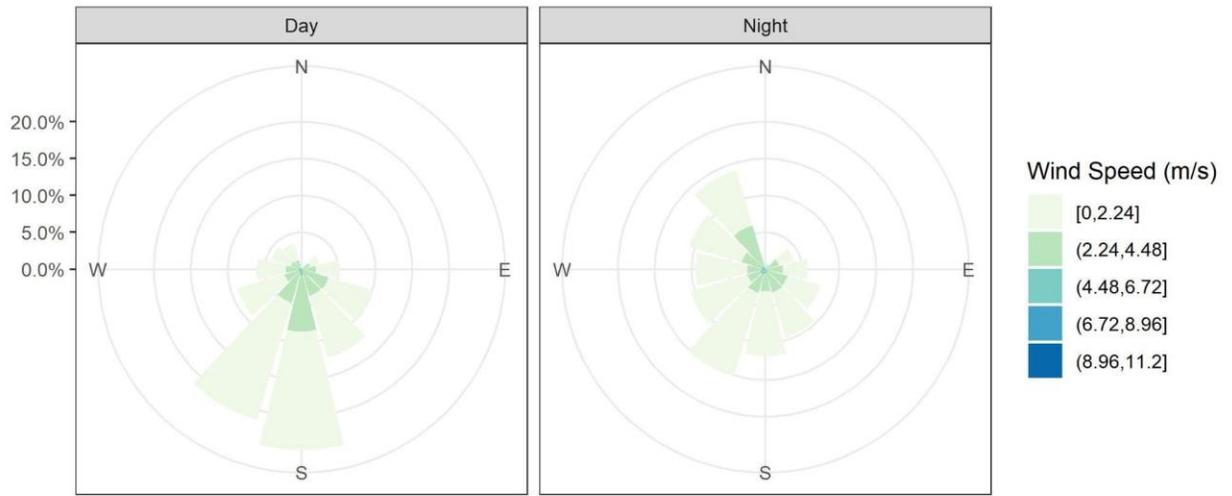
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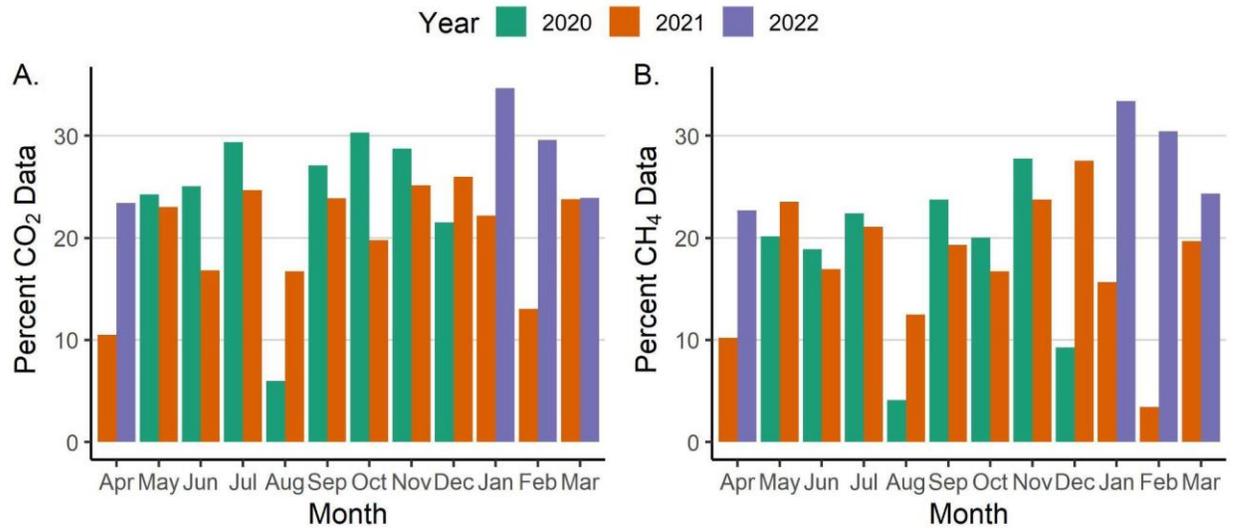
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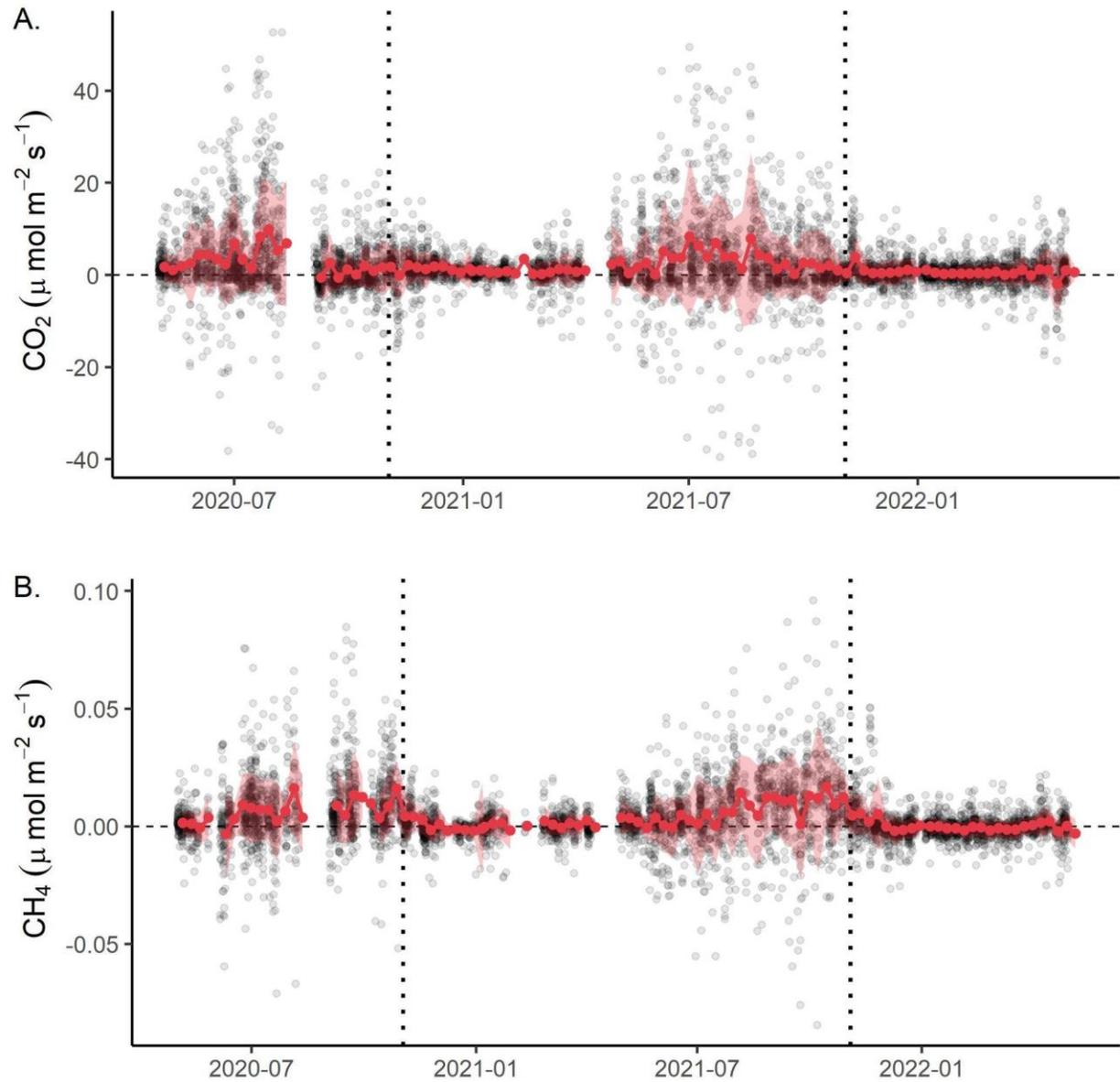
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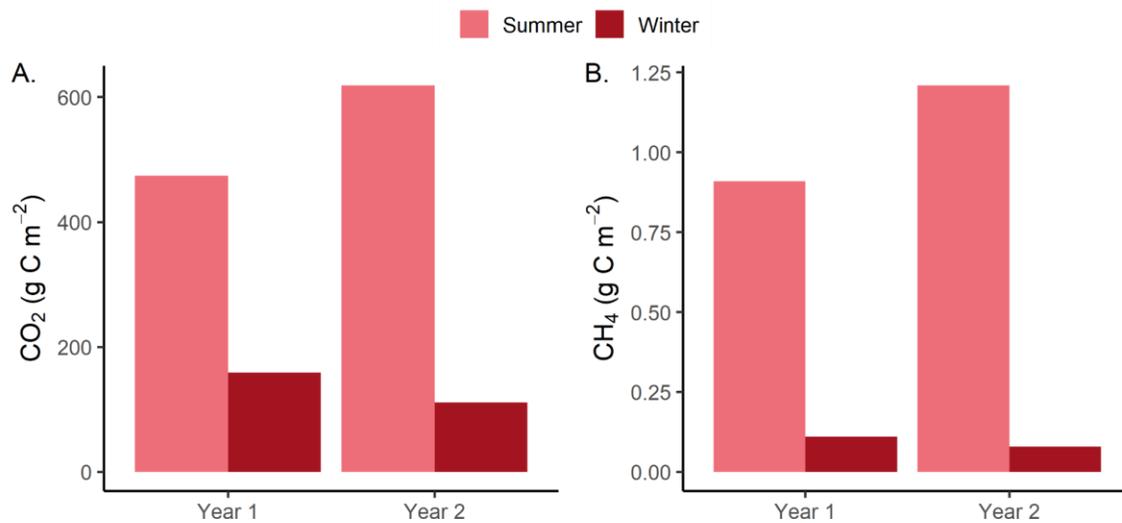
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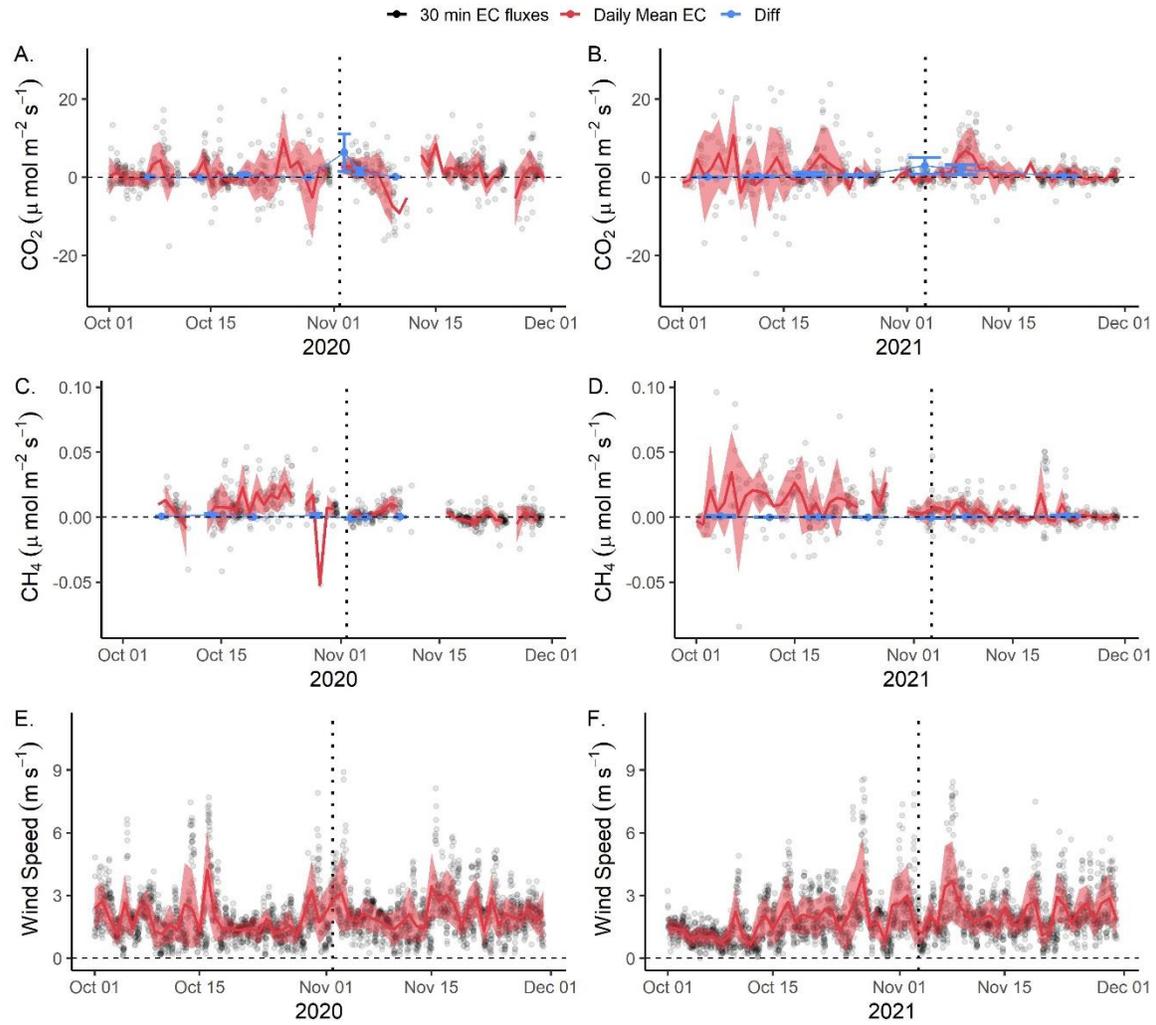
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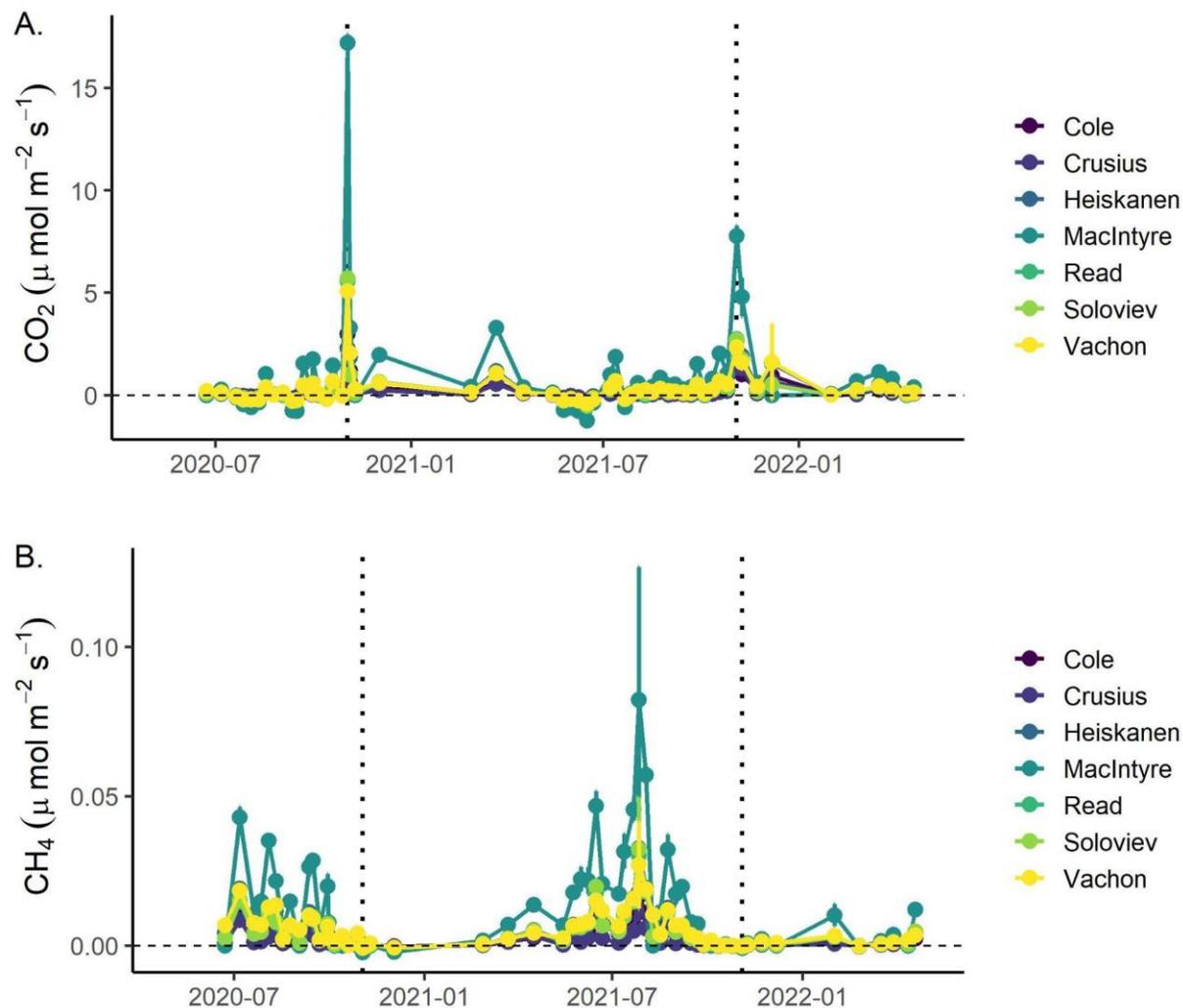
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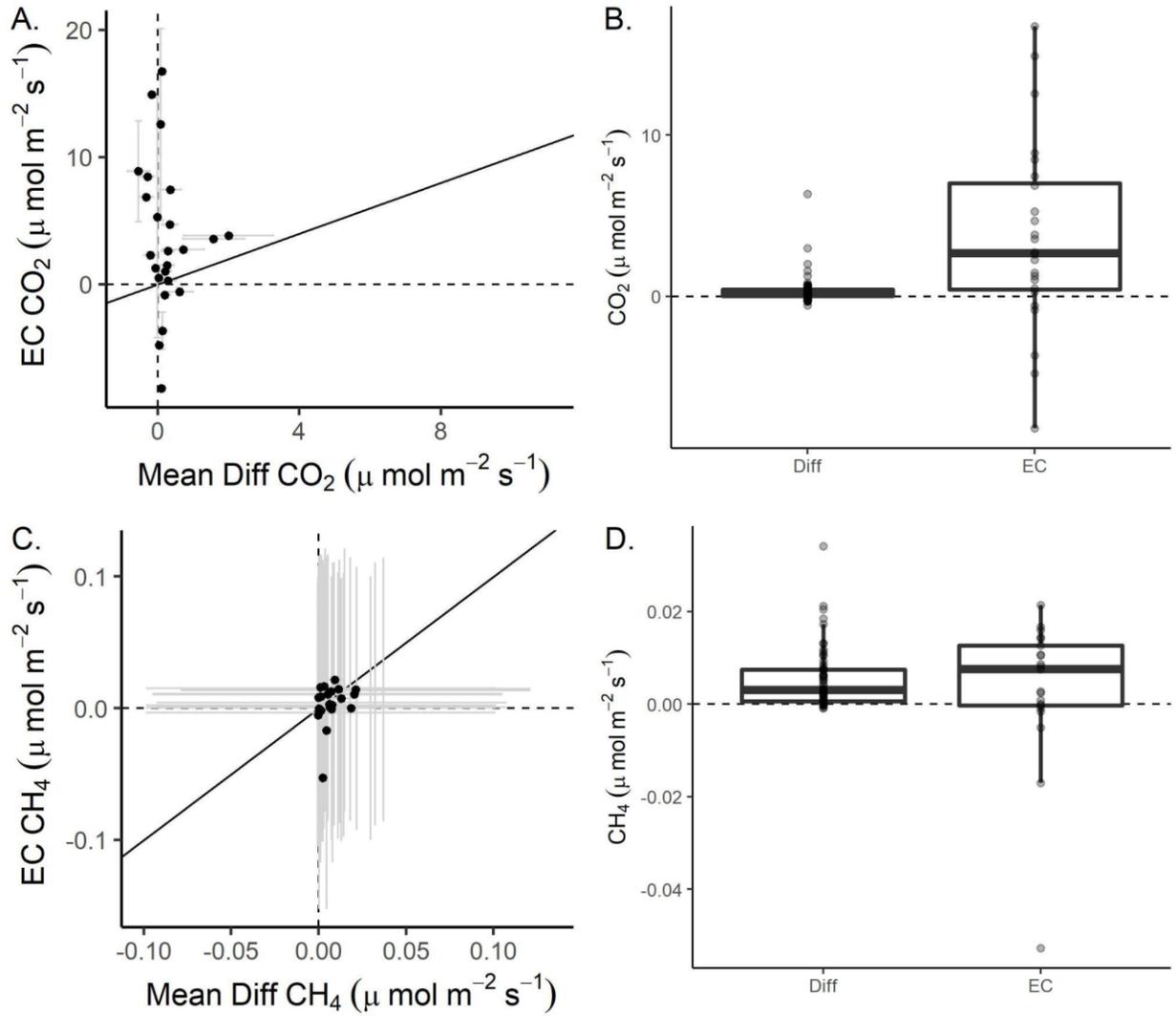
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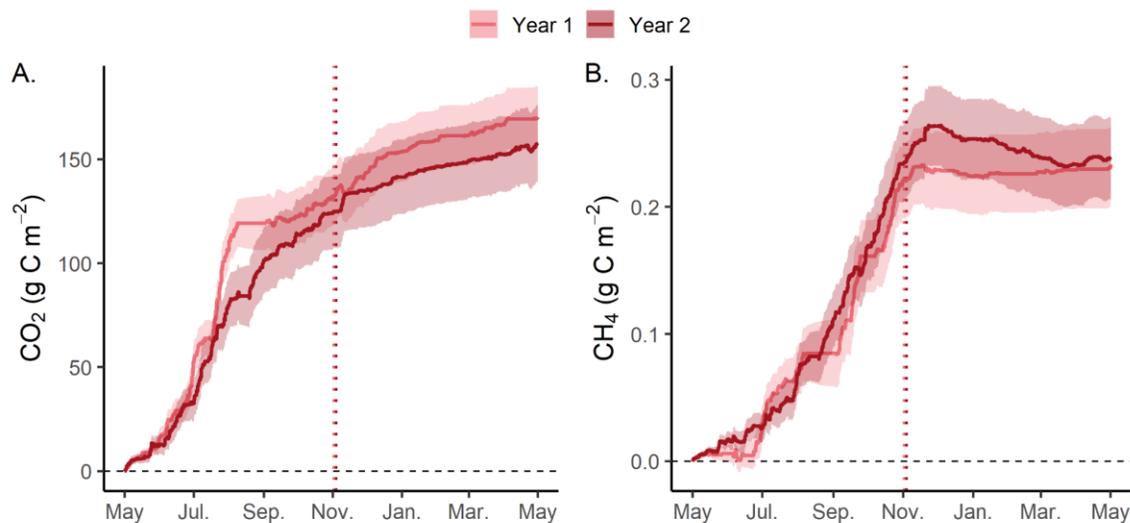
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	Start Date	End Date
Intermittent Ice on	10 January 2021	10 February 2021
Continuous Ice on	16 January 2022	10 February 2022

Table S1. Start and end dates used to define intermittent ice-on and continuous ice-on periods during the winter for 2020-2021 and winter 2021-2022 in Falling Creek Reservoir (Carey and Breef-Pilz, 2022).

	DO % Sat.	Chl-a (µg L^{-1})	fDOM (RFU)	Inflow (m^3 s^{-1})	Temp Diff.	N^2	Thermo Depth (m)
Hourly							
Surface Temp. (°C)	0.09	-0.50	0.39	0.04	0.94	0.90	-0.18
DO % Sat.		0.05	0.10	0.41	0.19	0.05	-0.15
Chl-a (µg L^{-1})			-0.19	-0.21	-0.46	-0.42	0.05
fDOM (RFU)				0.19	0.32	0.32	-0.11
Inflow (m^3 s^{-1})					0.17	0.01	-0.23
Temp Diff.						0.89	-0.34
N^2							-0.29
Daily							
Surface Temp. (°C)	0.04	-0.54	0.30	0.02	0.94	0.91	-0.01
DO % Sat.		0.10	0.01	0.39	0.12	0.00	-0.05
Chl-a (µg L^{-1})			-0.18	-0.16	-0.53	-0.49	-0.02
fDOM (RFU)				0.13	0.23	0.28	-0.05
Inflow (m^3 s^{-1})					0.14	-0.03	-0.18
Temp Diff.						0.92	-0.17
N^2							-0.15
Weekly							
Surface Temp. (°C)	0.10	-0.52	0.18	0.06	0.95	0.93	0.16
DO % Sat.		0.07	-0.07	0.39	0.17	0.06	-0.01
Chl-a (µg L^{-1})			-0.25	-0.19	-0.52	-0.50	-0.07
fDOM (RFU)				0.11	0.11	0.21	-0.09
Inflow (m^3 s^{-1})					0.14	0.00	-0.17
Temp Diff.						0.95	0.01
N^2							-0.01

| | Monthly | | | | | | |
	DO % Sat.	Chl-a ($\mu g\ L^{-1}$)	fDOM (RFU)	Inflow ($m^3\ s^{-1}$)	Temp Diff.	N^2	Thermo Depth (m)
Surface Temp. (°C)	0.16	-0.68	0.23	0.03	0.96	0.95	0.03
DO % Sat.		-0.15	-0.14	0.65	0.23	0.11	0.00
Chl-a ($\mu g\ L^{-1}$)			-0.45	-0.18	-0.68	-0.64	0.05
fDOM (RFU)				-0.03	0.16	0.30	-0.04
Inflow ($m^3\ s^{-1}$)					0.13	0.01	-0.27
Temp Diff.						0.96	-0.12
N^2							-0.11

Table S2. Correlations (Pearson's rho) among environmental parameters identified for the ARIMA analyses, including surface temperature (surface temp., °C), percent dissolved oxygen saturation (DO % Sat.), chlorophyll-*a* (Chl-a, $\mu g\ L^{-1}$), fluorescent dissolved organic matter (fDOM, relative fluorescence units, RFU), inflow ($m^3\ s^{-1}$), temperature difference (Temp Diff.) between the surface (0.1 m) and bottom (9 m), and buoyancy frequency (N^2). Highlighted boxes indicate environmental variables which were removed due to collinearity (rho>|0.70|).

	Percent available CO_2 fluxes (%)	Percent available CH_4 fluxes (%)
Raw data available	84	73
Removing fluxes from behind the dam (<80° and >250°)	59	52
QA/QC[*] of fluxes, LE[**], and H[***]	39	33
Removing fluxes outside of reservoir footprint	29	25
Removing fluxes with low u*	23	19

[*] QA/QC = Quality assurance/quality control
[**] Latent energy flux
[***] Sensible heat flux

Table S3. Percent of measured carbon dioxide (CO_2) and methane (CH_4) fluxes retained for analysis following data post-processing and various steps of data post-processing. See main manuscript for description of each post-processing step; all code is available in (Carey et al. 2022a).

		Minimum (μmol m^{-2} s^{-1})	Maximum (μmol m^{-2} s^{-1})	Median (μmol m^{-2} s^{-1})	Mean (μmol m^{-2} s^{-1})	Standard Deviation (μmol m^{-2} s^{-1})	Coefficient of Variation (%)
CH$_4$	Measured EC	-0.084	0.096	0.001	0.003	0.011	350.571
	Diffusive (Mean)	-0.0059	0.0928	0.0020	0.0048	0.0074	154.62
CO$_2$	Measured EC	-39.46	52.67	0.79	1.86	6.21	334.21
	Diffusive (Mean)	-1.24	17.50	0.11	0.38	1.22	325.66

Table S4. Minimum, maximum, median, mean, standard deviation, and coefficient of variation for measured methane (CH$_4$) and carbon dioxide (CO$_2$) fluxes for the study period (1 May 2020 to 30 April 2022) obtained from the eddy covariance (EC) system and mean diffusive fluxes. Mean diffusive fluxes represent all diffusive methods.

	25th Percentile	Median	75th Percentile	p-value
CO_2 (μmol m^{-2} s^{-1})				
Day	-0.44	1.05	3.91	
Night	-0.60	1.03	3.48	0.093
Dawn	-0.07	1.34	4.37	
Dusk	-0.66	-0.03	0.65	<0.001
CH_4 (μmol m^{-2} s^{-1})				
Day	-0.0017	0.0013	0.0079	
Night	-0.0016	0.0011	0.0066	0.162
Dawn	-0.0027	0.0002	0.0052	
Dusk	-0.0008	0.0014	0.0062	0.357
Wind (m s^{-1})				
Day	0.92	1.27	1.73	
Night	0.76	1.03	1.44	<0.001
Dawn	0.95	1.24	1.64	
Dusk	0.87	1.23	1.67	0.003

Table S5. Diel (day/night) and dawn/dusk comparisons for measured eddy covariance (EC) fluxes for carbon dioxide (CO_2, μmol m^{-2} s^{-1}) and methane (CH_4, μmol m^{-2} s^{-1}) along with wind (m s^{-1}). Day corresponds to measurements collected from 1100 to 1300 while night corresponds to 2300 to 0100 throughout the time period. Dawn corresponds to measurements collected from 0500 to 0700 and dusk corresponds to 1700 to 1900. Statistically significant differences ($p < 0.05$) based on paired Wilcoxon sign-rank tests are highlighted in grey.

	Year 1	Year 2	Total Study Period
Mean Temp. (^{o}C)	13.8	14.4	14.1
Min. Temp. (^{o}C)	-9.93	-11.5	
Max. Temp. (^{o}C)	35.1	35.0	
Mean Wind Speed (m s^{-1})	2.00	1.97	1.99
Max. Wind Speed (m s^{-1})	9.28	11.2	
Dominant Wind Direction (^{o})	191	199	198
Total Rainfall (mm)	1438	790	2228

Table S6. Various climatological variables calculated for Falling Creek Reservoir (FCR) for Year 1 (01 May 2020-30 April 2021), Year 2 (01 May 2021-30 April 2022), and the full study period calculated from the meteorological station deployed at the dam.

	Year 1	Year 2	Total Study Period
Mean Surface Temp. (^{o}C)	15.2	15.9	15.6
Min. Surface Temp. (^{o}C)	1.23	1.88	
Max. Surface Temp. (^{o}C)	31.4	31.3	
Mean Chl-a (μg L^{-1})	11.5	12.3	11.9
Min. Chl-a (μg L^{-1})	1.34	0.25	
Max Chla (μg L^{-1})	90.3	121	
Mean fDOM (RFU)	6.09	6.04	6.1
Min. fDOM (RFU)	3.19	3.01	
Max. fDOM (RFU)	10.4	8.79	
Mean % DO	107	97.8	102
Min. % DO	8.12	0	
Max. % DO	220	208	
Mean Inflow (m^3 s^{-1})	0.056	0.013	0.034
Min. Inflow (m^3 s^{-1})	0.005	0.006	
Max. Inflow (m^3 s^{-1})	0.27	0.20	

Table S7. Mean, minimum, and maximum calculated for key environmental variables from Falling Creek Reservoir during year 1 (May 2020 - April 2021) and year 2 (May 2021 - April 2022) including: Surface temperature, Chlorophyll-a (Chl-a), fluorescent dissolved organic matter (fDOM, RFU), percent dissolved oxygen (% DO), and inflow.

GHG	Order	AR(1)	MA(1)	MA(2)	Temp. Surf. (°C)	% DO Sat.	Chl-a ($\mu g\ L^{-1}$)	fDOM (RFU)	Flow ($m^3\ s^{-1}$)	Thermo. (m)	AICc	RMSE
					Daily							
CO_2	(1,0,0)	0.11			0.18		-0.17	0.07	0.08	-0.09	1281.69	0.97
S.E.		0.05			0.07		0.06	0.05	0.05	0.05		
CO_2	(1,0,0)	0.10			0.20	-0.07	-0.14	0.07	0.12	-0.09	1281.79	0.97
S.E.		0.05			0.07	0.05	0.06	0.05	0.06	0.05		
CO_2	(0,0,2)		0.11	0.05	0.20		-0.17		0.08	-0.09	1282.98	0.97
S.E.			0.05	0.05	0.07		0.06		0.05	0.05		
CO_2	(0,0,2)		0.10	0.04	0.22	-0.07	-0.15		0.11	-0.09	1283.35	0.97
S.E.			0.05	0.05	0.07	0.05	0.06		0.06	0.05		
CH_4	(0,0,0)				0.27			0.12		0.25	1213.36	1.02
S.E.					0.05			0.05		0.05		
CH_4	(0,0,0)				0.28	-0.04		0.12		0.25	1214.53	1.02
S.E.					0.05	0.04		0.05		0.05		
CH_4	(0,0,0)				0.28		0.02	0.12		0.25	1215.30	1.02
S.E.					0.07		0.06	0.05		0.05		

GHG	Order	AR(1)	MA(1)	MA(2)	Temp. Surf. (ºC)	% DO Sat.	Chl-a (µg L^{-1})	fDOM (RFU)	Flow (m^3 s^{-1})	Thermo. (m)	AICc	RMSE
						Weekly						
CO_2	(0,0,0)				0.64	-0.16		0.13	0.20	-0.19	183.00	0.63
S.E.					0.07	0.07		0.07	0.08	0.07		
CO_2	(0,0,0)				0.67	-0.17			0.19	-0.20	184.05	0.64
S.E.					0.07	0.07			0.08	0.07		
CH_4	(0,1,1)		-0.75		0.36			0.23	-0.36	0.24	184.13	0.64
S.E.			0.09		0.15			0.10	0.13	0.08		
CH_4	(0,1,1)		-0.65					0.28	-0.43	0.21	185.88	0.65
S.E.			0.09					0.11	0.15	0.08		
						Monthly						
CO_2	(0,0,0)				0.73			0.24		-0.31	42.58	0.48
S.E.					0.10			0.10		0.10		
CO_2	(0,0,0)				0.71	0.15		0.27		-0.32	43.55	0.45
S.E.					0.10	0.10		0.10		0.10		
CO_2	(0,0,0)				0.73			0.27	0.15	-0.26	43.88	0.46
S.E.					0.10			0.10	0.10	0.10		
CH_4	(0,0,1)		0.72		0.74				-0.26	0.21	38.85	0.41
S.E.			0.18		0.14				0.12	0.07		

Table S8. Best-fit results from Autoregressive Integrated Moving Average (ARIMA) showing the top selected model (lowest corrected Akaike Information Criterion, AICc < 2). Models are separated by greenhouse gas (GHG) flux as carbon dioxide fluxes (CO_2) and methane fluxes (CH_4) as well as by timescale (daily, weekly, monthly). Environmental predictors included: Surface temperature (Surface Temp, ^oC), dissolved oxygen saturation (DO Sat, %), Chlorophyll-*a* (Chl-a, $\mu g\ L^{-1}$), fluorescent dissolved organic matter (fDOM, RFU), inflow discharge (Inflow, $m^3\ s^{-1}$), and thermocline depth (Thermo. depth, m). Model order is specified as (p,d,q) where p is the order of the AR term, d is the order of the integration term, and q is the order of the MA term. Results for all models with 2 AICc of the best fitting model are included. The root mean square error (RMSE) is also reported for each model. Shaded model results are included in the main manuscript (Table 1). S.E. is the standard error.

	25th Percentile	Median	75th Percentile	p-value
CO_2 ($\mu mol\ m^{-2}\ s^{-1}$)				
Intermittent ice-on (Year 1)	0.12	0.71	1.34	<0.001
Continuous Ice-on (Year 2)	-0.34	0.28	0.93	
CH_4 ($\mu mol\ m^{-2}\ s^{-1}$)				
Intermittent ice-on (Year 1)	-0.001	0.001	0.004	<0.001
Continuous Ice-on (Year 2)	-0.002	-0.001	0.000	

Table S9. 25th percentile, median, and 75th percentile reported measured eddy covariance (EC) data for carbon dioxide (CO_2, $\mu mol\ m^{-2}\ s^{-1}$) and methane (CH_4, $\mu mol\ m^{-2}\ s^{-1}$) fluxes during winter 2020-2021 (year 1) under partial ice-on ('On') and during winter 2021-2022 (year 2) under continuous ice-on. The Mann-Whitney-Wilcoxon test was used to identify medians which were statistically different. Statistically significant relationships are highlighted in grey.