

Supplementary Information

CO₂ influx and efflux circadian cycles in bare dry lake sediments

Pelin Ertürk Arı¹, Rafael Marcé², Oriol Sacristán-Soriano^{4,11}, Duygu Tolunay³, Carles M. Borrego^{4,5}, Sílvia Poblador⁹, Biel Obrador⁶, Enrique Moreno-Ostos⁷, Jorge J. Montes-Pérez⁶, Teresa Conejo-Orosa⁷, Matthias Koschorreck⁸, Josep Peñuelas^{9,10}, Núria Catalán²

¹ Bolu Abant İzzet Baysal University, Environmental Engineering, Bolu, Turkey

² Center for Advanced Studies of Blanes (CEAB-CSIC), Spain

³ A-LIFE (Amsterdam Institute of Life Science and Environment) Section Systems Ecology, Vrije Universiteit Amsterdam, Amsterdam 1081 HV, the Netherlands

⁴ Catalan Institute for Water Research (ICRA), Spain

⁵ Group of Molecular Microbial Ecology, Institute of Aquatic Ecology, University of Girona, Spain

⁶ Departament de Biologia Evolutiva, Ecologia i Ciències Ambientals, Universitat de Barcelona (UB), Barcelona, Spain

⁷ Department of Ecology, Marine Ecology and Limnology Research Group, University of Málaga, Spain.

⁸ Department of Lake Research, Helmholtz Centre for Environmental Research (UFZ), Germany

⁹ CREAF, Cerdanyola del Vallès, Barcelona, Spain

¹⁰ CSIC, Global Ecology Unit CREAF-CSIC-UAB, Bellaterra, Barcelona, Spain

¹¹ Technological Center in Biodiversity, Ecology and Environmental and Food Technology, University of Vic–Central University of Catalonia (CT BETA UVic-UCC), Spain.

Correspondence to: Núria Catalán (nuria.catalan@ceab.csic)

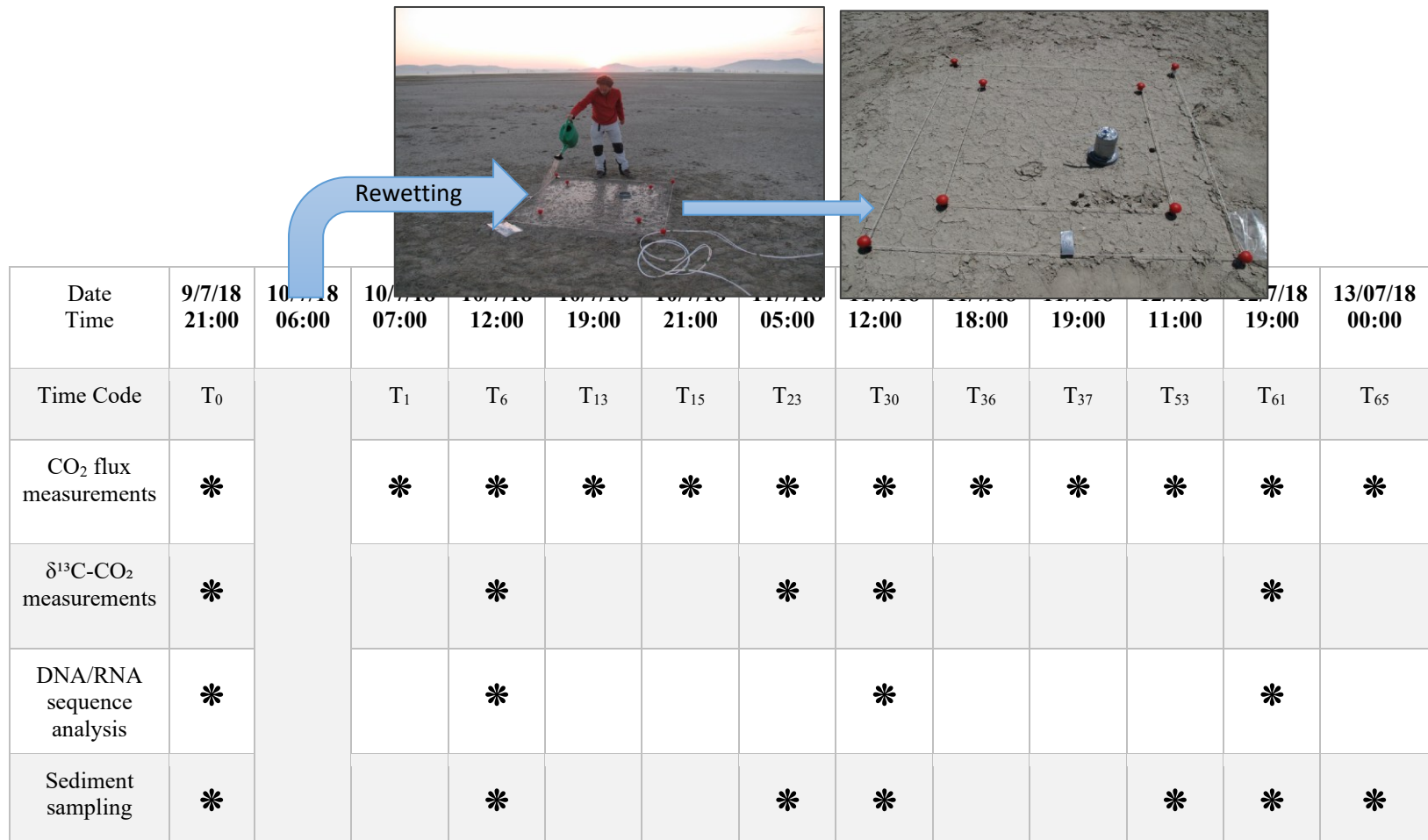


Figure S1: Time schedule for the rewetting experiment and sampling of the different methods. Rewetting (i.e. artificial rain) was done the 10th July at 6:00. So T1 is one hour after the rewetting. T0 refers to the reference sampling performed before the start of the experiment

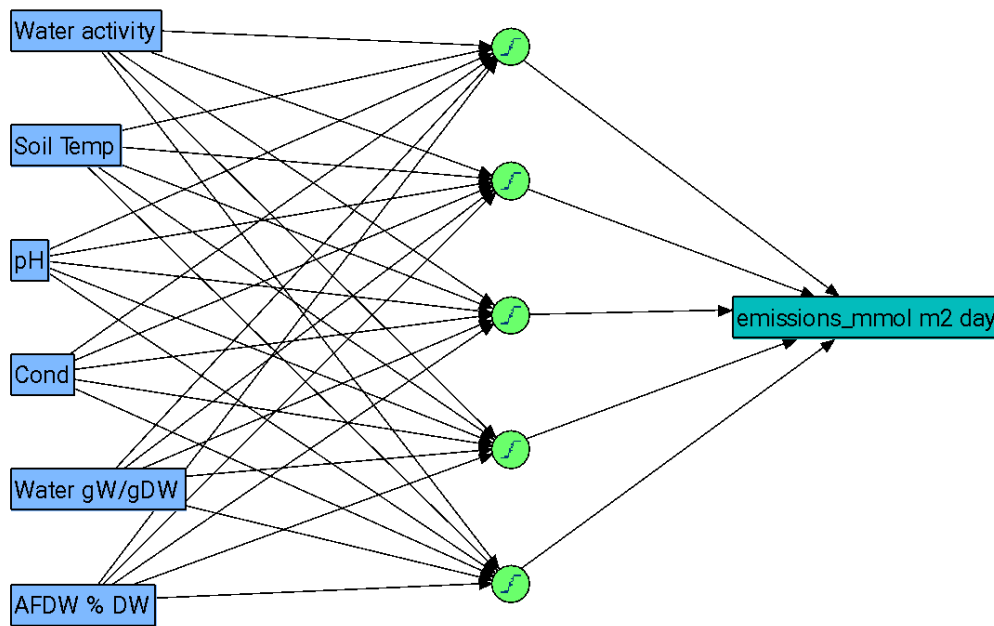


Figure S2: The diagram of best fit ANN built in the present study. Emissions_mmol m2 day refer to the CO₂ emissions from the dry sediments.

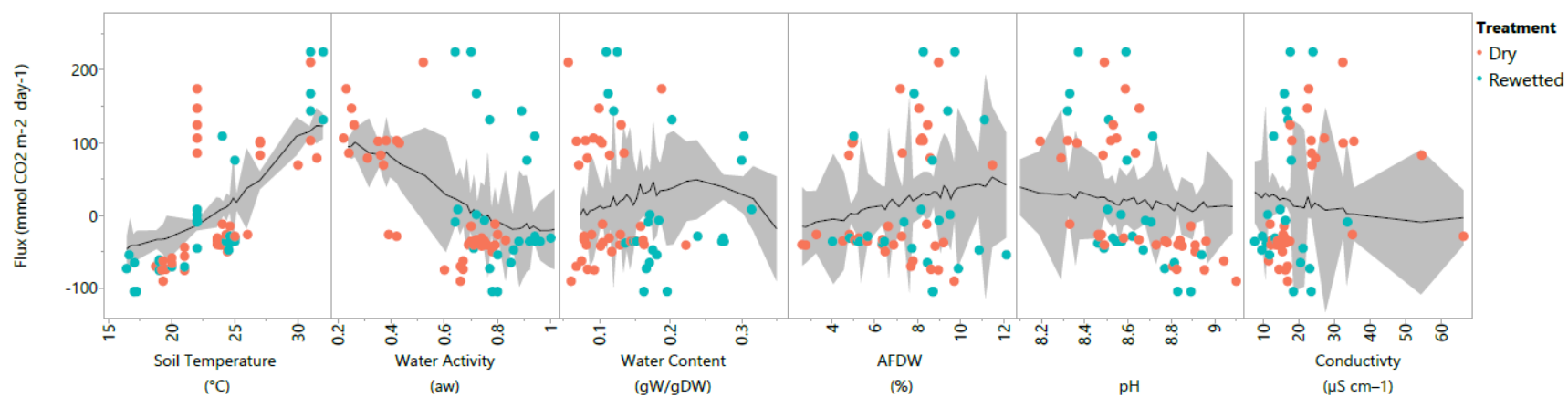


Figure S3: Marginal model plots of the main effects of factors derived from the ANN and Monte Carlo resampling analysis.

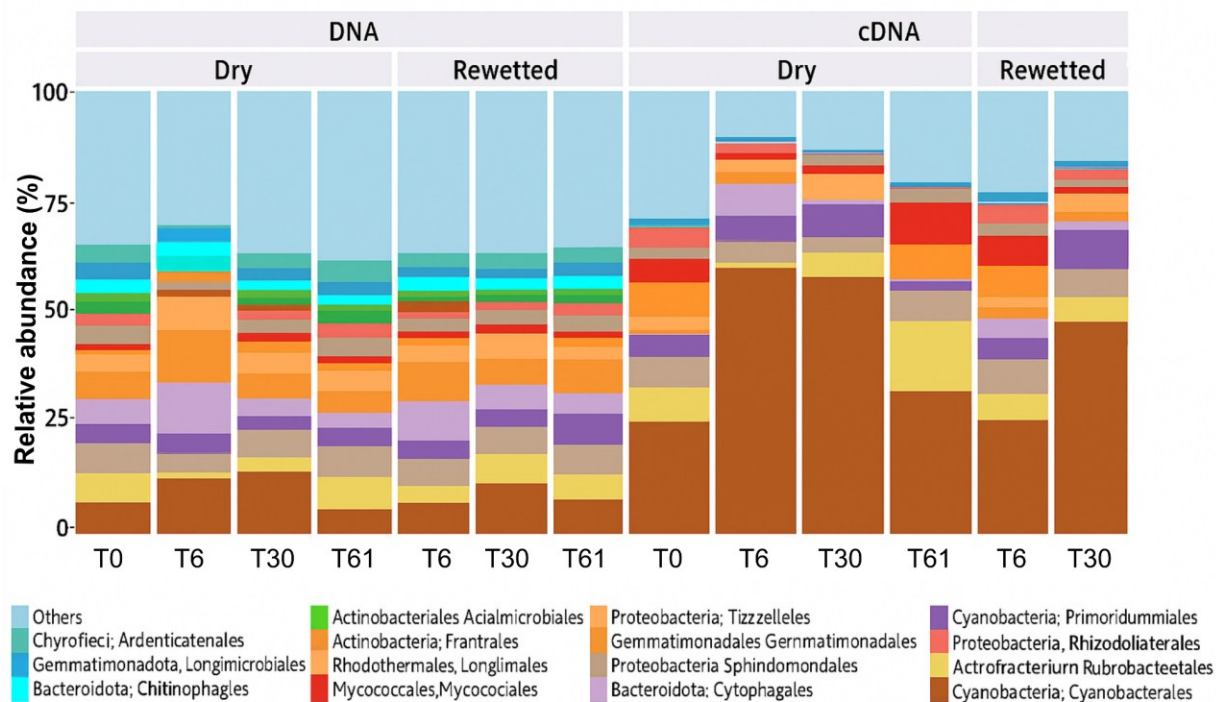


Figure S4: Relative abundance of the different orders found for the Dry and Rewetted treatments across the incubation times (T0, T6, T30 and T61). Please, note that not all the samples could be retrieved at each time. The number of replicates with which each column has been calculated is as follows (DNA: 6, 1, 5, 3, 4, 5, 5; cDNA: 3, 1, 2, 1, 4, 1)

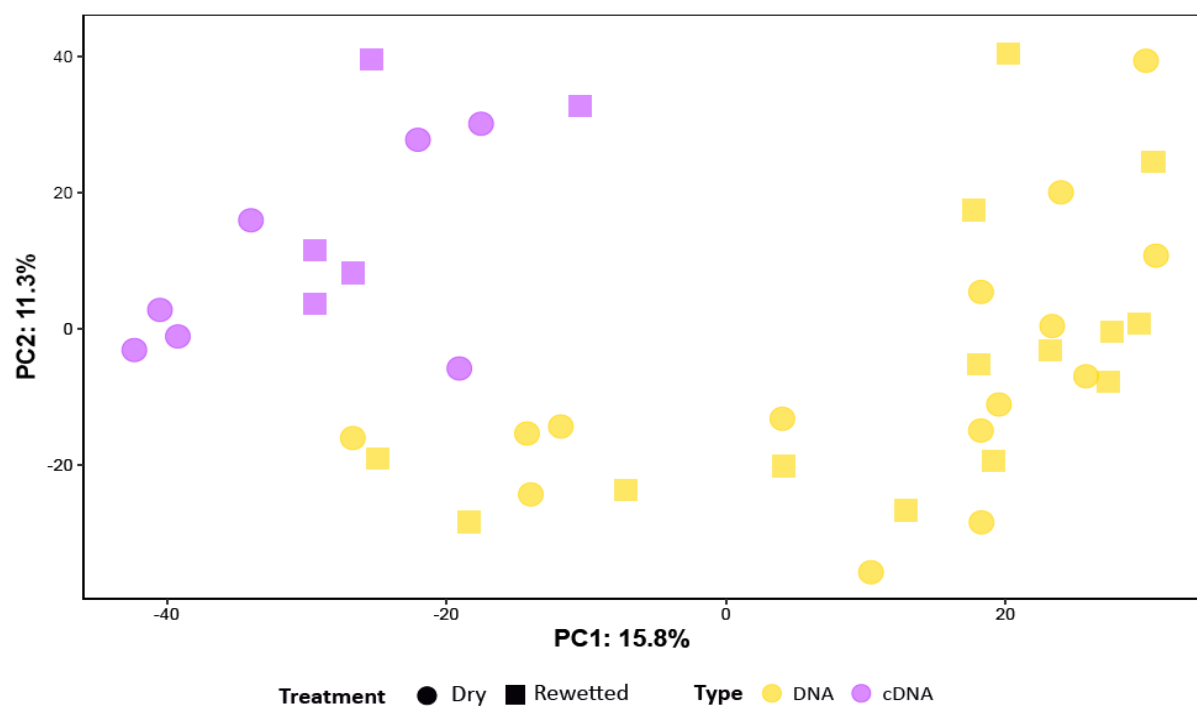


Figure S5: Principal components analysis (PCA) on all samples (DNA and cDNA) across all treatments and times.

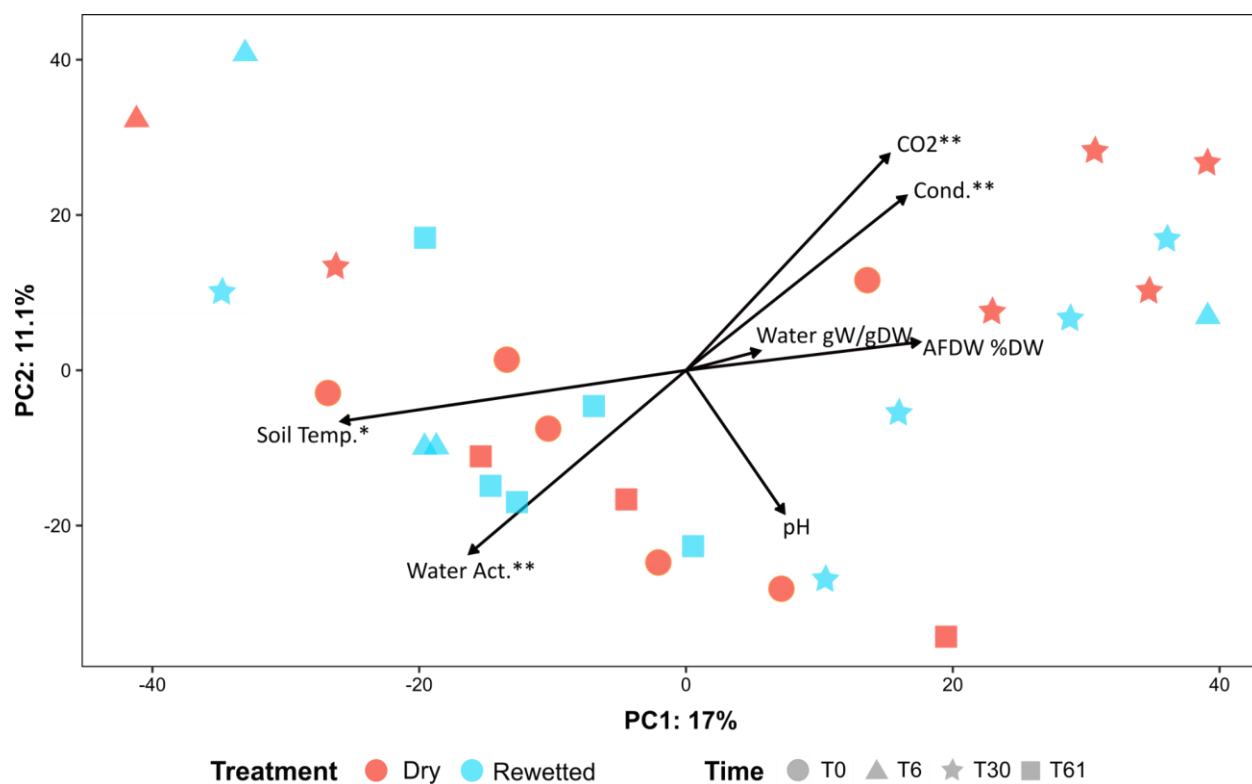


Figure S6: Principal components analysis (PCA) results for DNA regarding the fitting of the environmental variables. *means a significance level of $p < 0.05$, and ** means a significance level of $p < 0.01$

Table S1. Variabilities of sediment properties (mean and standard deviations) in response to time, treatment and their interaction based on LMM. Differences between factors were tested using a Type III ANOVA. Then, differences between factor levels were tested using a Student's t-test for treatment and a Tukey HSD multiple comparison test for time. AFDW = Ash-free dry weight.

	Water Content (gW/gDW)	Water activity (a _w)	pH	Conductivity	Soil Temp	Bulk Density g/cm ³	AFDW (%)
T0 (Initial)	0.15 (0.035)	0.75 (0.047)	8.8 (0.14)	15 (1.6)	24 (0.33)	1.0 (0.28)	5.5 (2.3)
Treatment	F-value=95 <i>p</i> <0.0001	F-value=811 <i>p</i> <0.0001	F-value=0.85 <i>p</i> =0.39	F-value=16 <i>p</i> =0.0037	F-value=43 <i>p</i> <0.0001	F-value=0.75 <i>p</i> =0.41	F-value=0.49 <i>p</i> =0.51
Dry	0.10 (0.028)	0.49 (0.19)	8.6 (0.25)	24 (13.)	24 (4.0)	0.95 (0.16)	7.5 (1.7)
Rewetted	0.20 (0.071)	0.82 (0.16)	8.6 (0.16)	16 (6.0)	23 (4.7)	0.91 (0.21)	7.9 (2.1)
Time	F-value=9.1 <i>p</i> <0.0001	F-value=68. <i>p</i> <0.0001	F-value=34. <i>p</i> <0.0001	F-value=10 <i>p</i> <0.0001	F-value=790 <i>p</i> <0.0001	F-value=2.6 <i>p</i> =0.05	F-value=23 <i>p</i> <0.0001
T6	0.19 (0.10) ^a	0.67 (0.30) ^b	8.5 (0.14) ^{bc}	29 (20) ^a	26 (1.1) ^b	0.95 (0.18) ^a	5.5 (1.4) ^c
T23	0.13 (0.053) ^{bc}	0.73 (0.083) ^b	8.9 (0.11) ^a	17 (4.2) ^b	18 (1.3) ^f	0.97 (0.15) ^a	9.1 (1.3) ^a
T30	0.19 (0.089) ^{ab}	0.47 (0.24) ^d	8.6 (0.075) ^b	21 (6.5) ^{ab}	22 (0.00) ^d	1.0 (0.19) ^a	8.1 (0.75) ^{ab}
T53	0.11 (0.040) ^c	0.57 (0.20) ^c	8.4 (0.16) ^c	21 (5.2) ^{ab}	31 (0.6) ^a	0.83 (0.19) ^a	9.2 (1.3) ^a
T61	0.14 (0.047) ^{abc}	0.84 (0.11) ^a	8.6 (0.12) ^b	12 (2.6) ^b	24 (0.40) ^c	0.84 (0.16) ^a	6.8 (1.7) ^{bc}
T65					20 (0.88) ^e		
Treatment & Time	F-value=5.0 <i>p</i> =0.0023	F-value=26 <i>p</i> <0.0001	F-value=2.6 <i>p</i> =0.05	F-value=13 <i>p</i> <0.0001	F-value=13 <i>p</i> <0.0001	F-value=1.8 <i>p</i> =0.155	F-value=0.29 <i>p</i> =0.88
Dry T6	0.091 (0.018) ^{cd}	0.39 (0.035) ^c	8.4 (0.12) ^c	45 (15) ^a	26 (0.89) ^b	0.89 (0.16) ^a	5.4 (1.1) ^b
Rewetted T6	0.29 (0.015) ^a	0.95 (0.033) ^a	8.56(0.10) ^{bc}	13 (3.7) ^b	25 (0.45) ^c	1.0 (0.20) ^a	5.6 (1.8) ^b
Dry T23	0.075 (0.013) ^d	0.65 (0.029) ^d	9.0 (0.13) ^a	15 (2.3) ^b	19 (0.30) ^f	1.00 (0.11) ^a	8.5 (0.84) ^{ab}

Rewetted T23	0.18 (0.013) ^{bc}	0.80 (0.031) ^{bc}	8.9 (0.067) ^{ab}	20 (4.8) ^b	17 (0.33) ^g	0.95 (0.20) ^a	9.6 (1.5) ^a
Dry T30	0.13 (0.037) ^{cd}	0.24 (0.015) ^f	8.6 (0.052) ^{bc}	23 (3.5) ^b	22 (0.00) ^d	1.1 (0.20) ^a	7.8 (0.57) ^{ab}
Rewetted T30	0.24 (0.092) ^{ab}	0.69 (0.047) ^{bc}	8.6 (0.0099) ^{bc}	19 (8.7) ^b	22(0.00) ^d	1.0(0.20) ^a	8.3 (0.89) ^{ab}
Dry T53	0.078 (0.016) ^d	0.40 (0.077) ^e	8.3 (0.18) ^c	25 (5.1) ^b	31 (0.55) ^a	0.97 (0.12) ^a	9.1 (1.4) ^a
Rewetted T53	0.13 (0.038) ^{cd}	0.74 (0.093) ^{cd}	8.4 (0.12) ^c	18. (3.3) ^b	31 (0.55) ^a	0.69 (0.13) ^a	9.3 (1.3) ^a
Dry T61	0.10 (0.021) ^{cd}	0.74 (0.032) ^{cd}	8.7 (0.15) ^c	14 (1.9) ^b	24 (0.17) ^c	0.84 (0.14) ^a	6.6 (1.2) ^{ab}
Rewetted T61	0.17 (0.041) ^{bcd}	0.93 (0.066) ^{ab}	8.8 (0.078) ^{bc}	10 (2.3) ^b	25 (0.18) ^c	0.86 (0.20) ^a	6.9 (2.3) ^{ab}
Dry T65					21 (0.55) ^e		
Rewetted T65					20 (0.89) ^{ef}		

Table S2. Variabilities of CO₂ fluxes (mmol m⁻² d⁻¹) responses to treatment, time, and interaction between treatment and time based on LMM followed by comparisons tests (Student's t test for treatments, $p=0.0178$; Tukey HSD multiple comparison tests for time and interactions treatment and time, $p< 0.0001$).

	Mean (SD) CO ₂
T0 (Initial)	-35 (9.5)
Treatment	F-value= 8.8 $p=0.0178$
Dry	- 4.1 (76) ^a
Rewetted	-16 (74) ^b
Time	F-value= 46 $p<0.0001$
T1	-84 (30) ^g
T6	31 (67) ^{bc}
T13	-22 (12) ^{de}
T15	-40 (25) ^{defg}
T23	-77 (17) ^{fg}
T30	59 (78) ^b
T36	-2.6 (16) ^{cd}
T37	-26 (14) ^{de}
T53	146 (59) ^a
T61	-34 (9.5) ^{def}
T65	-63 (9.8) ^{efg}
Treatment & Time	F-value= 6.38 $p<0.0001$

Dry T1	-101 (9.8) ^g
Rewetted T1	-66 (34) ^{fg}
Dry T6	46 (68) ^{bc}
Rewetted T6	17 (71) ^{cd}
Dry T13	-20 (7.0) ^{cdef}
Rewetted T13	-24 (16) ^{cdef}
Dry T15	-27 (12) ^{cdef}
Rewetted T15	-52 (29) ^{defg}
Dry T23	-74 (10) ^{fg}
Rewetted T23	-80 (23) ^{fg}
Dry T30	128 (34.58) ^a
Rewetted T30	-10 (21) ^{cdef}
Dry T36	8.5 (11) ^{cde}
Rewetted T36	-14 (13) ^{cdef}
Dry T37	-27 (10) ^{cdef}
Rewetted T37	-26 (19) ^{cdef}
Dry T53	113 (57) ^{ab}
Rewetted T53	179 (44) ^a
Dry T61	-31 (12) ^{defg}
Rewetted T61	-37 (6.8) ^{defg}
Dry T65	-60 (11) ^{efg}
Rewetted T65	-68 (6.0) ^{fg}

Table S3. Pairwise comparison for the PERMANOVA on B-diversity

	ADONIS test	
	r^2	p -value
R_RNA vs R_DNA	0.109	$p = 0.009$
D_RNA vs D_DNA	0.122	$p < 0.001$
D_DNA vs R_DNA	0.110	$p < 0.001$
D_RNA vs R_RNA	0.117	$p > 0.05$
D_DNA vs R_RNA	0.151	$p = 0.002$
D_RNA vs R_DNA	0.053	$p > 0.05$