Supplement of Biogeosciences, 16, 2511–2526, 2019
https://doi.org/10.5194/bg-16-2511-2019-supplement

Biogeosciences Open Access EGU

Supplement of

Humic surface waters of frozen peat bogs (permafrost zone) are highly resistant to bio- and photodegradation

Liudmila S. Shirokova et al.

Correspondence to: Oleg S. Pokrovsky (oleg.pokrovsky@get.omp.eu)

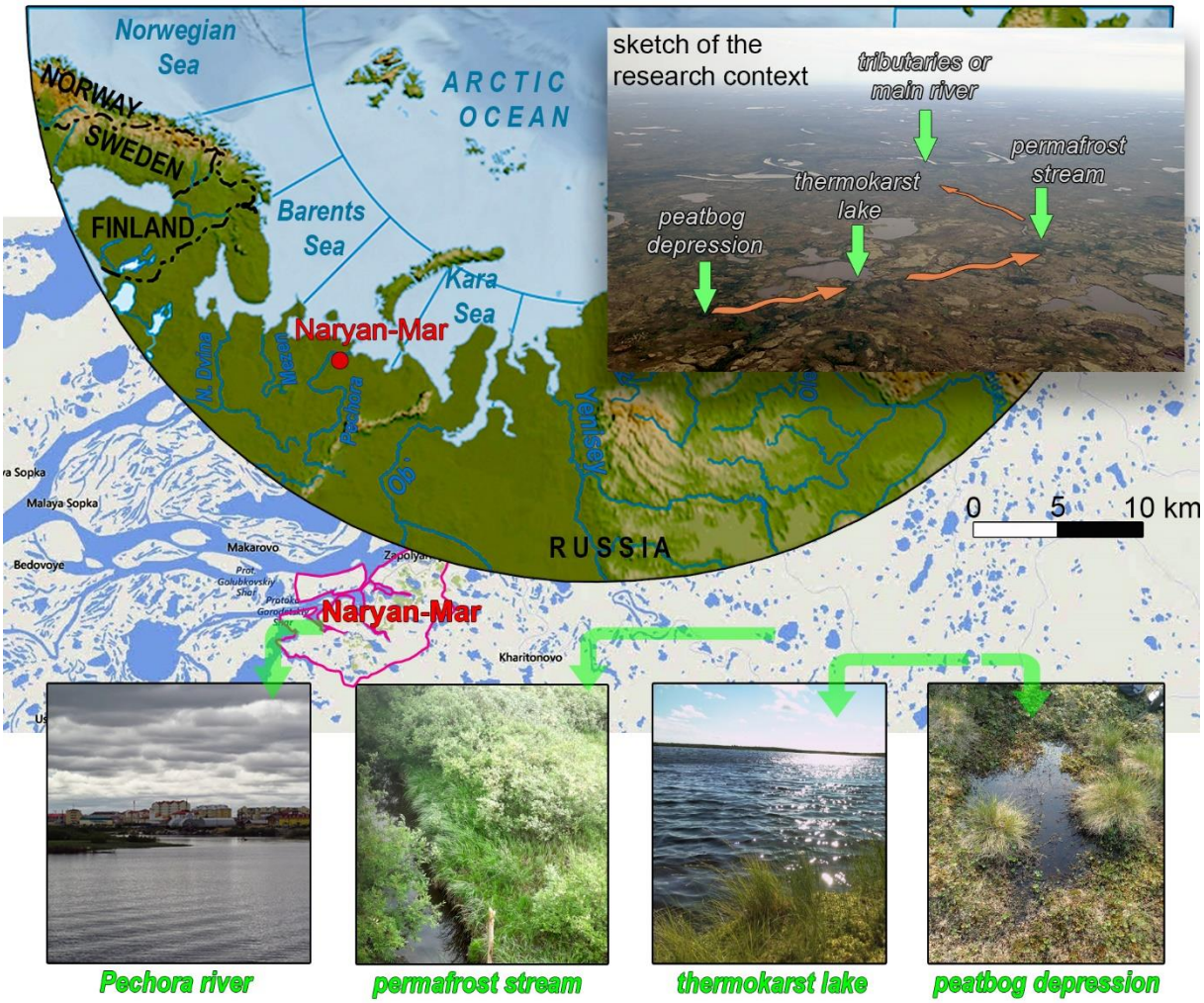

Fig. S1. The map of studied hydrological continuum and ground photos of sampled aquatic systems.

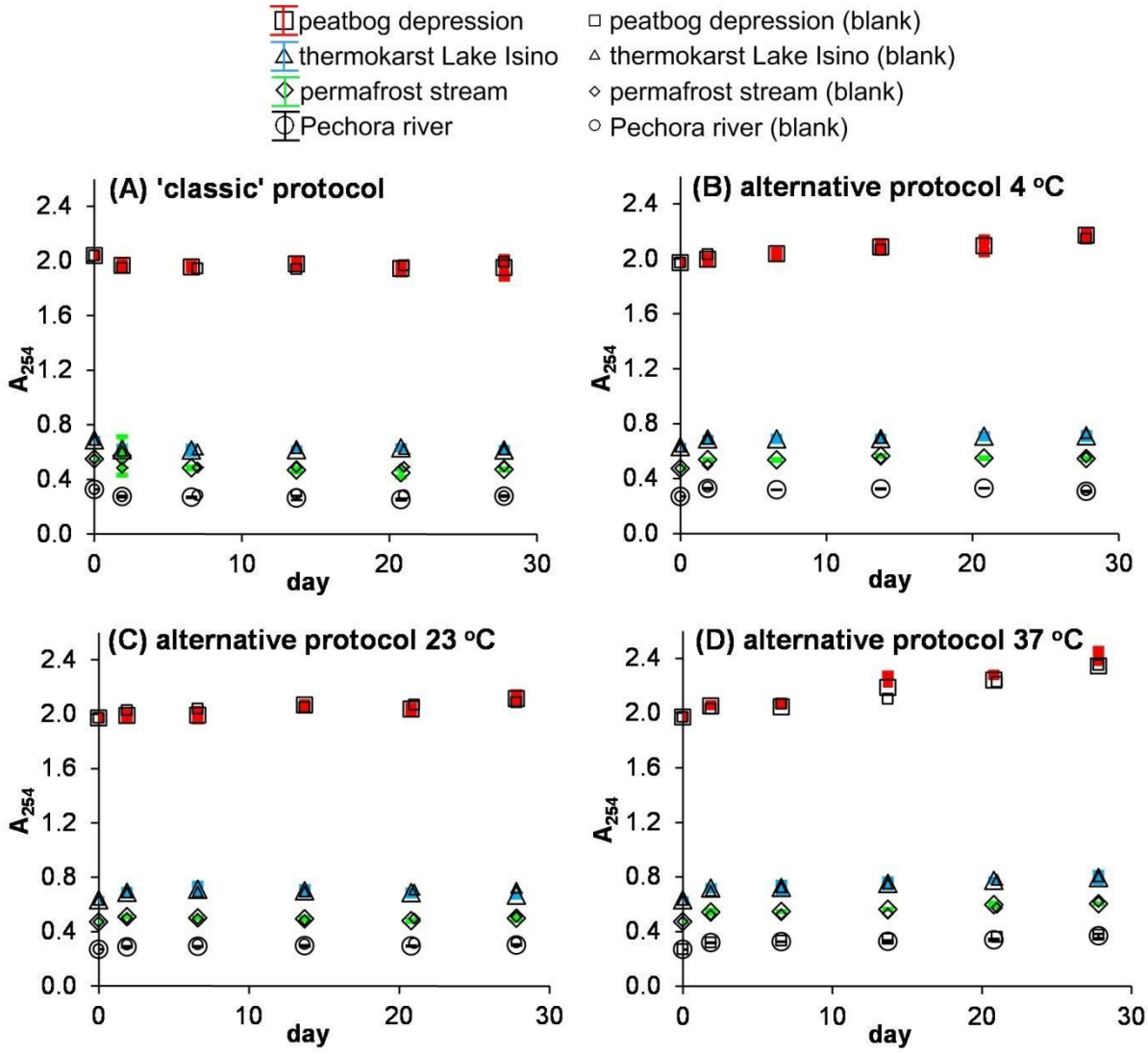

Fig. S2. UV absorbency at 254 nm in biodegradation experiments. The error bars are 1 s.d. of triplicates.

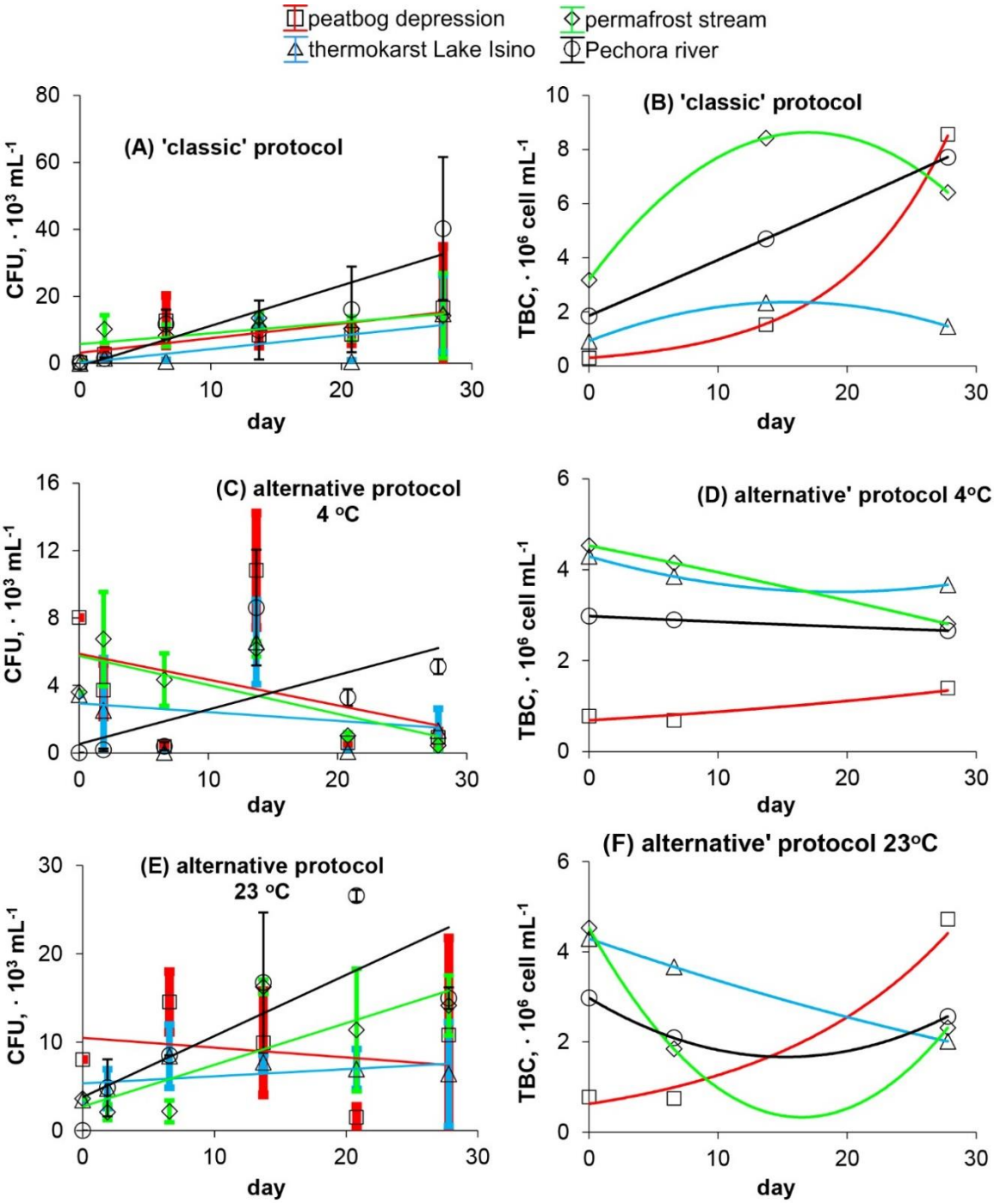

Fig. S3. Number of colony-forming units of oligotrophic bacteria (A, C, E) and DAPI-based total bacteria count (B, D, F) at 23°C in GF/F- filtered experiment of ‘classic‘ protocol (**A, B**), at 4°C (C, D) and 23°C in alternative (3 µm – filtration) protocol (**E** and **F**). The error bars on CFU are 1 s.d. of triplicates, and the average error bars on TBC are ±10%.

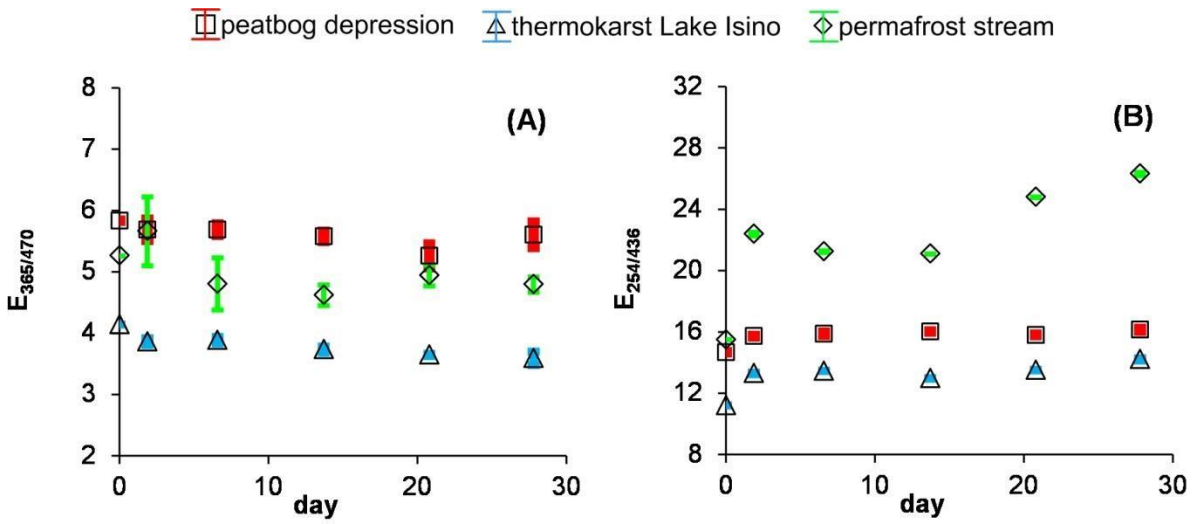

Fig. S4. The optical properties of DOC during photodegrdation experiments: E_{365}/E_{470} ratio corresponding to UV/vis absorbing functional groups (**A),** and the E_{254}/E_{436} ratio, corresponding to autochthonous vs. terrestrial DOM **(B).** The error bars are 1 s.d. of triplicates.

Table S1. Primary data on chemistry of solutions during experiments (average of 3 replicates), together with microbial counts.

experiment	substrate	Time, day	pH	æ, µS/cm	DOC, mg/L	DIC, mg/L	A_{254}	E 365/470	E 254/436	E 280/350	TBC, · 10^6 cell/ml	OB, CFU/ml
biodegradation 'classic' protocol	peatbog depression	0	3.45	44	46.7	0.95	2.04	5.71	14.47	2.499	0.3	270
		2	3.5	38	46.9	1.00	1.97	6.0	12.38	2.51	-	2773
		7	3.28	41	51.2	0.98	1.96	6.01	15.3	2.518	1.534	12760
		14	3.6	40	48.0*	1.05	1.98	6.10	15.38	2.523	-	8498
		21	3.19	38.1	47.5*	0.95	1.95	6.1	15.6	2.528	-	8692
		28	3.8	40	50.5*	1.02	1.95	5.94	15.2	2.522	8.57	16630
	thermokarst lake	0	4.09	13	15.3	0.80	0.689	4.220	11.5	2.48	0.918	40
		2	5.61	22	15.8	0.85	0.62	4.0	10.8	2.43	-	1540
		7	5.1	18	16.4*	0.78	0.61	4.6	13.3	2.50	2.34	598
		14	5.2	21	17.5*	0.90	0.617	4.7	13.3	2.53	-	12178
		21	4.8	20	18.1*	0.85	0.632	4.65	12.8	2.50	-	480
		28	4.4	26	17.8*	0.82	0.616	4	10.6	2.53	1.465	14840
	permafrost stream	0	5.38	27	13.9	2.45	0.55	5.4	16.2	2.65	3.175	520
		2	6.2	31	14.9	2.52	0.57	4.5	13	3	-	10253
		7	5.9	33	15.2*	2.50	0.485	4.0	13.0	2.64	8.43	8320
		14	5.1	34	16.1*	2.65	0.47	5.9	18	2.76	-	13529
		21	5.0	34	15.1*	2.60	0.45	6.3	18	2.83	-	10387
		28	4.7	37	15.5*	2.70	0.474	4.7	15	2.7	6.418	14267
	Pechora river	0	5.81	51	7.68	5.95	0.33	5	14.9	2.73	1.855	320
		2	6.1	49	9.05	5.90	0.274	8	20.9	3.1	-	1467
		7	6.65	54.4	10.5	6.05	0.269	9	25	3.09	4.697	11730
		14	6.8	59	11.5*	6.00	0.26	14	33	3.10	-	9935
		21	7.04	58.3	11.9*	6.07	0.253	20	24	3.24	-	16120
		28	6.2	60	10.5*	6.05	0.278	10	30	3.05	7.721	40267
biodegradation alternative protocol 4°C	peatbog depression	0	3.23	45.3	43.5	0.95	1.971	5.963	14.6	2.514	0.78	8030
		2	3.205	46.2	46.03	1.05	2.00	5.86	14.51	2.531	-	3720
		7	3.03	50	46.8	0.95	2.04	5.8	14.55	2.532	0.685	375
		14	3.15	50.5	46.4	1.02	2.09	5.77	15.55	2.5490	-	10827
		21	3.06	48	47.6*	1.05	2.09	5.98	14.64	2.547	-	600
		28	3.51	52	47.3*	0.95	2.17	5.6	14.77	2.533	1.396	921
	thermokarst lake	0	4.03	11.2	14.4	0.75	0.633	5	12.412	2.49	4.294	3440
		2	5.2	12	15.6	0.80	0.688	4.56	12.06	2.565		2528
		7	4.84	14	15.4	0.82	0.69	4.5	12.76	2.57	3.85	30
		14	4.64	11.75	16.2*	0.75	0.690	5.1	12.32	2.57		6577
		21	4.74	13	15.8*	0.80	0.708	4.68	12.10	2.5520		80
		28	4.8	9.7	15.5*	0.78	0.71	5.05	12.57	2.58	3.670	1320
	permafrost stream	0	5.19	24.2	12.43	2.50	0.472	8.333	18.154	2.773	4.532	3600
		2	5.1	24.1	14.9	2.45	0.538	7.6	17.07	2.771		6750
		7	5.90	24.3	14.2	2.48	0.537	7.53	17.32	2.77	4.148	4340
		14	5.71	25.1	13.5*	2.55	0.566	5.8	10.383	2.705		6160
		21	5.73	25	15.1*	2.45	0.549	7.34	16.634	2.745	2.808	1015
		28	5.80	23.7	14.8*	2.65	0.544	9.1	18.45	2.8034		443.5
	Pechora river	0	5.85	50.3	7.46	5.90	0.270	6.571	33.75	3.046	2.98	5
		2	6.1	51.7	8.68	6.05	0.327	12	19.84	2.85		180
		7	6.3	53.7	8.16	5.94	0.3185	13	22.0	2.863	2.896	400
		14	6.52	53	9.77	6.02	0.326	10.4	19.2	2.84		8613.5
		21	6.51	54.9	10.6	5.93	0.3295	10.8	20.7	2.84		3280
		28	6.42	52.8	9.42	6.04	0.307	5.8	17.56	2.68	2.660	5115

Footnote: the DOC concentration numbers with asterisk * were corrected for [DOC] evolution in control experiments for consistency

Table S1, continued.

experiment	substrate	Time, day	pH	æ, µS/cm	DOC, mg/L	DIC, mg/L	A_{254}	E 365/470	E 254/436	E 280/350	TBC, $\cdot 10^6$ cell/ml	OB, CFU/ml
biodegradation alternative protocol 23°C	peatbog depression	0	3.23	45.3	43.5	N.D.	1.971	5.963	14.600	2.514	0.78	8030
		2	3.2	48.8	45.9	N.D.	1.99	5.8	14.69	2.527		-
		7	3.05	47.35	45.8	N.D.	1.99	5.4	14.45	2.45	0.746	14540
		14	3.155	49.9	43.9	N.D.	2.067	5.8	14.50	2.521		9920
		21	3.12	45	47.0	N.D.	2.04	5.72	14.76	2.514		1500
		28	3.47	50.9	45.9	N.D.	2.12	5.7	14.29	2.522	4.721	10800
	thermokarst lake	0	4.03	11.2	14.4	N.D.	0.633	5.000	12.412	2.490	4.294	3440
		2	4.0	11.0	15.0	N.D.	0.69	4.3	11.106	14		4750
		7	5.0	11.5	14.5	N.D.	0.71	4.7	11.03	2.45	3.666	8420
		14	4.70	12.2	13.4	N.D.	0.70	4.743	12.06	2.50		7707
		21	4.78	9.6	13.9	N.D.	0.69	4.78	11.91	2.48		6965
		28	4.88	10	13.7	N.D.	0.668	4.2	11.32	2.51	2.012	6400
	permafrost stream	0	5.19	24.2	12.43	N.D.	0.472	8.333	18.154	2.773	4.532	3600
		2	5.13	22.6	14.03	N.D.	0.510	5.5	15.45	2.64		2080
		7	6.02	24.1	14.3	N.D.	0.501	5.8	16.16	2.82	1.845	2177.5
		14	5.92	25.8	12.5	N.D.	0.495	6.0	19.0	2.83		16267
		21	5.89	24.0	13.1	N.D.	0.480	6.9	17.1	2.806		11385
		28	5.9	22	12.2	N.D.	0.50	5.7	16.04	2.717	2.312	14160
	Pechora river	0	5.85	50.3	7.46	N.D.	0.270	6.571	33.75	3.046	2.980	5
		2	6.2	51	7.76	N.D.	0.288	34	24.2	3.3		4840
		7	6.55	53.4	7.60	N.D.	0.292	12	26.63	2.97	2.090	8510
		14	6.8	54	7.58	N.D.	0.296	33	33.275	3.0		16747
		21	6.79	54.5	7.7	N.D.	0.294	6	33.0	3.01		26560
		28	6.66	56	7.9	N.D.	0.302	5.8	15.89	2.778	2.567	14970
biodegradation alternative protocol 37°C	peatbog depression	0	3.23	45.3	43.50	0.95	1.971	5.9625	14.6	2.514	-	0
		2	3.4	47	47.3	0.99	2.051	5.90	12.94	2.53	-	0
		7	3.05	51.1	48.6	0.98	2.04	5.71	13.19	2.50	-	0
		14	3.075	53	49.3	1.05	2.19	5.3	12.1	2.1	-	0
		21	3.12	51.9	48.5*	1.00	2.24	5.81	12.2	2.4838	-	0
		28	3.35	53	47.3*	1.02	2.3	5.10	12.707	2.457	-	0
	thermokarst lake	0	4.03	11.2	14.44	0.82	0.633	5.0	12.412	2.490	-	0
		2	5.1	11.3	15.2*	0.85	0.72	11	9.4	2.590	-	0
		7	5.0	12.9	15.8*	0.95	0.72	4.8	9.35	2.4	-	0
		14	4.6	14.95	16.3*	0.91	0.75	5.1	10.05	2.548	-	0
		21	4.87	14	16.1*	0.85	0.774	4.9	9.669	2.541	-	0
		28	4.7	10	15.9*	0.90	0.80	3.9	10.68	2.44	-	0
	permafrost stream	0	5.19	24.2	12.43	2.50	0.472	8.3	18.2	2.773	-	0
		2	6.0	24.6	13.5*	2.45	0.54	5.6	15.1	2.68	-	0
		7	6.3	25.0	15.3	2.62	0.547	4.6	14.78	2.660	-	0
		14	5.99	29.2	14.2*	2.72	0.564	5.6	14.84	2.642	-	0
		21	6.22	27.8	16.1*	2.65	0.60	5.4	16.16	2.73	-	0
		28	6.26	27	15.5*	2.59	0.605	4.9	14.07	2.64	-	0
	Pechora river	0	5.85	50.3	7.46	5.85	0.270	6.6	33.75	3.046	-	0
		2	6.50	52	9.06	5.95	0.319	8	22.89	2.86	-	0
		7	6.68	54	8.49	5.90	0.327	6.8	18.67	2.82	-	0
		14	6.81	55.3	8.52	6.02	0.329	7	18.36	2.8	-	0
		21	6.98	58.4	8.85*	6.00	0.340	11	23.67	3.2	-	0
		28	6.94	55	9.1*	6.05	0.37	5.0	13.90	2.646	-	0

Table S1, continued.

experiment	substrate	Time, day	pH	æ, µS/cm	DOC, mg/L	DIC, mg/L	A_{254}	E 365/470	E 254/436	E 280/350	OB, CFU/ml	P, µg/L	Fe, µg/L	B, µg/L	Ti, µg/L	V, µg/L	Zn, µg/L	Zr, µg/L	Nb, µg/L	Th, µg/L
photodegradation	peatbog depression	0	3.67	41.3	46.6	0.99	2.084	5.84	14.68	2.51	-	16.6	169	5.6	0.820	0.52	88.6	0.0553	0.0063	0.0055
		2	2.93	51	46.6	0.95	1.974	5.7	15.73	2.56	-	16.0	181	5.4	0.816	0.54	113.1	0.0610	0.0059	0.0059
		7	3.17	46	46.9	1.02	1.937	5.69	15.88	2.59	-	14.6	189	7.3	0.832	0.54	76.4	0.0611	0.0067	0.0061
		14	3.07	49.7	45.5	1.05	1.930	5.58	16.02	2.64	-	12.8	195	6.8	0.818	0.55	60.6	0.0609	0.0061	0.0061
		21	3.16	46	45.0	1.05	1.849	5.3	15.80	2.62	-	15.0	198	6.3	0.801	0.58	80.8	0.0630	0.0061	0.0057
		28	3.34	49	44.6	0.95	1.808	5.61	16.14	2.55	< 10	12.3	193	5.9	0.824	0.54	69.6	0.0637	0.0068	0.0061
	thermokarst lake	0	4.69	12.5	16.3	0.81	0.706	4.14	11.21	2.49	-	10.0	361	3.7	0.497	0.53	85.8	0.0505	0.0021	0.0053
		2	3.81	11.1	15.5	0.85	0.651	3.86	13.29	2.59	-	11.9	351	4.6	0.473	0.513	105	0.0474	0.0017	0.0049
		7	4.69	11.9	15.7	0.75	0.639	3.88	13.45	2.65	-	9.28	349	4.8	0.435	0.518	90.7	0.0475	0.0016	0.0053
		14	4.26	12.7	15.0	0.80	0.629	3.73	12.96	2.64	-	6.67	340	6.4	0.444	0.509	71.6	0.0422	0.0016	0.0040
		21	4.42	12	14.1	0.85	0.601	3.64	13.51	2.67	-	7.79	330	6.0	0.376	0.50	73.0	0.0454	0.0013	0.0044
		28	4.65	14	14.6	0.88	0.590	3.59	14.21	2.70	< 10	5.45	334	5.7	0.394	0.504	69.4	0.0396	0.0012	0.0034
	permafrost stream	0	4.88	22.6	15.3	2.55	0.542	5.261	15.49	2.66	-	11.74	409	13.0	0.764	0.589	82.8	0.1520	0.0033	0.0153
		2	5.15	24.0	14.8	2.60	0.504	5.661	22.39	2.89	-	9.20	383	12.4	0.738	0.568	91.8	0.1580	0.0032	0.018
		7	5.72	25.0	14.4	2.48	0.478	4.803	21.24	2.99	-	7.26	349	11.9	0.745	0.565	71.7	0.1576	0.0030	0.019
		14	5.44	25.7	15.2	2.52	0.464	4.618	21.09	2.97	-	5.50	297	12.3	0.658	0.522	70.7	0.1451	0.0028	0.0155
		21	5.42	24.75	14.2	2.50	0.445	4.943	24.79	3.07	-	6.77	257	12.8	0.611	0.492	74.9	0.1434	0.0025	0.016
		28	5.61	24.7	14.5	2.65	0.434	4.794	26.30	3.06	< 10	4.60	269	12.3	0.548	0.511	72.3	0.1262	0.0023	0.0136