



*Supplement of*

## **Shifting mineral and redox controls on carbon cycling in seasonally flooded mineral soils**

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### **Figure Captions**

Figure S1. van Krevelen diagrams that visualize FTICRMS data of three different samples (horizons) from the lowland position and their replicates

Figure S2. van Krevelen diagrams that visualize FTICRMS data from three different samples (horizons) from the transition position and their replicates

Figure S3. Van Krevelen diagrams that visualize FTICRMS data from three different samples (horizons) from the upland position and their replicates

Table S1 Average environmental characteristics  $\pm$  standard errors along upland-to-lowland transects by season

	Cover (%)	Soil Temp (C°)	Soil Temp (C°)	Water Table Depth (cm)	Water Table Depth (cm)	Volumetric Moisture Content (%)	Volumetric Moisture Content (%)
	GS	GS	NGS	GS	NGS	GS	NGS
Upland position	39 <sup>a</sup> $\pm$ 7	17 <sup>a</sup> $\pm$ 0.4	7 <sup>a</sup> $\pm$ 0.5	-38 <sup>b</sup> $\pm$ 3	-46 <sup>a</sup> $\pm$ 3	0.30 <sup>a</sup> $\pm$ 0.05	0.23 <sup>a</sup> $\pm$ 0.02
Transition position	34 <sup>a</sup> $\pm$ 8	16 <sup>a</sup> $\pm$ 0.4	6 <sup>a</sup> $\pm$ 0.5	-20 <sup>a</sup> $\pm$ 6	-35 <sup>a</sup> $\pm$ 5	0.35 <sup>ab</sup> $\pm$ 0.05	0.24 <sup>a</sup> $\pm$ 0.04
Lowland position	21 <sup>a</sup> $\pm$ 8	17 <sup>a</sup> $\pm$ 0.3	6 <sup>a</sup> $\pm$ 0.5	-3 <sup>c</sup> $\pm$ 5	-18 <sup>b</sup> $\pm$ 6	0.50 <sup>b</sup> $\pm$ 0.03	0.38 <sup>b</sup> $\pm$ 0.04

Seasons are defined as either growing season (GS) or non-growing season (NGS).

Soil temperature and volumetric moisture content were taken at 10cm soil depth.

Letter designations are Tukey's HSD results. Different letter designations indicate a p-value of  $< 0.05$ .

Table S2 Average soil redox potentials  $\pm$  standard error along upland-to-lowland transects by season

	$E_h$ (mV)	$E_h$ (mV)
	GS	NGS
<b>Upland</b>		
A	$494^a \pm 44$	$595^a \pm 23$
B	$457^a \pm 59$	$605^a \pm 42$
C	$393^a \pm 60$	$618^a \pm 36$
<b>Transition</b>		
A	$243^a \pm 77$	$581^a \pm 23$
B/C	$139^a \pm 51$	$484^a \pm 47$
Cg	$191^{ab} \pm 71$	$476^a \pm 47$
<b>Lowland</b>		
A	$95^b \pm 34$	$414^a \pm 97$
C	$71^b \pm 23$	$453^a \pm 61$
Cg	$73^b \pm 33$	$435^a \pm 83$

Seasons are defined as either growing season (GS) or non-growing season (NGS).

Mean redox values were assigned to soil horizons using an equal area spline function based on redox values measured at 15-, 30-, and 45 cm depths.

Letter designations indicate significant differences on a horizon basis as determined by ANOVA followed by Tukey's HSD. Different letter designations indicate a p-value of  $< 0.05$ .

Table S3 Fixed effect parameters from the linear mixed models along the upland-to-lowland transects

Variable	Degrees of freedom	Regression Coefficient ± standard error	F - value	Prob > F	Landscape Position Prob >F
<b>A-horizon</b>					
Root Biomass	19	0.21 ± 0.14	0.00	NS	<0.05
Fe <sub>o</sub>	20	0.07 ± 0.19	0.96	NS	NS
Al <sub>o</sub>	20	0.72 ± 0.26	3.71	NS	<0.05
Clay	19	0.01 ± 0.27	0.13	NS	NS
E <sub>h</sub>	24	-0.30 ± 0.24	6.32	<0.05	NS
<b>B/C-horizon</b>					
Root Biomass	19	-0.17 ± 0.11	5.41	<0.05	NS
Fe <sub>o</sub>	20	0.26 ± 0.14	0.71	NS	<0.01
Al <sub>o</sub>	20	0.38 ± 0.11	6.05	<0.05	<0.05
Clay	19	0.30 ± 0.13	7.01	<0.01	<0.05
E <sub>h</sub>	24	0.11 ± 0.12	0.06	NS	<0.05
<b>C/Cg-horizon</b>					
Root Biomass	19	0.01 ± 0.2	2.90	NS	<0.05
Fe <sub>o</sub>	20	0.004 ± 0.02	0.08	NS	NS
Al <sub>o</sub>	20	0.09 ± 0.03	16.10	<0.01	NS
Clay	19	0.01 ± 0.03	3.65	NS	<0.05
E <sub>h</sub>	24	-0.05 ± 0.04	2.84	NS	<0.01

Model parameters with p-values > 0.05 are denoted as not-significant with the letters NS.

Table S4 Average relative abundance ± standard error of carbon functional groups of solid samples identified by C NEXAFS along upland-to-lowland transects

	Phenolic	Aromatic	Aliphatic	Carboxylic & Amide	Alkyl-OH	Carbonyl	Carboxylic : Aromatic
<b>Upland</b>							
A	12 <sup>a</sup> ± 0.6	14 <sup>a</sup> ± 1.3	7 <sup>b</sup> ± 0.6	29 <sup>a</sup> ± 0.8	20 <sup>a</sup> ± 0.9	19 <sup>a</sup> ± 0.5	2.24 <sup>a</sup> ± 0.22
B	8 <sup>a</sup> ± 1.9	8 <sup>a</sup> ± 1.3	5 <sup>a</sup> ± 1.2	37 <sup>a</sup> ± 0.8	24 <sup>a</sup> ± 1.4	19 <sup>a</sup> ± 0.2	5.77 <sup>a</sup> ± 1.62
C	9 <sup>a</sup> ± 0.7	11 <sup>a</sup> ± 1.9	5 <sup>a</sup> ± 1.6	34 <sup>a</sup> ± 1.7	22 <sup>a</sup> ± 1.3	19 <sup>a</sup> ± 1.3	3.96 <sup>a</sup> ± 0.97
<b>Transition</b>							
A	12 <sup>a</sup> ± 0.5	15 <sup>a</sup> ± 1.2	10 <sup>a</sup> ± 0.5	26 <sup>ab</sup> ± 1.1	19 <sup>a</sup> ± 0.5	19 <sup>a</sup> ± 0.4	1.84 <sup>a</sup> ± 0.23
B/C	10 <sup>a</sup> ± 0.6	12 <sup>ab</sup> ± 1.4	6 <sup>ab</sup> ± 0.9	35 <sup>a</sup> ± 2.2	22 <sup>a</sup> ± 0.5	15 <sup>a</sup> ± 2.5	3.33 <sup>a</sup> ± 0.48
Cg	7 <sup>a</sup> ± 1.3	12 <sup>a</sup> ± 3.3	4 <sup>a</sup> ± 0.8	32 <sup>a</sup> ± 1.9	22 <sup>a</sup> ± 2.3	23 <sup>a</sup> ± 0.5	3.31 <sup>a</sup> ± 1.10
<b>Lowland</b>							
A	12 <sup>a</sup> ± 0.6	16 <sup>a</sup> ± 0.8	12 <sup>c</sup> ± 0.3	24 <sup>b</sup> ± 0.8	19 <sup>a</sup> ± 0.5	18 <sup>a</sup> ± 0.4	1.54 <sup>a</sup> ± 0.12
C	11 <sup>a</sup> ± 0.4	13 <sup>b</sup> ± 0.8	10 <sup>b</sup> ± 1.2	28 <sup>b</sup> ± 1.3	21 <sup>a</sup> ± 0.9	18 <sup>a</sup> ± 0.4	2.26 <sup>a</sup> ± 0.27
Cg	10 <sup>a</sup> ± 0.7	8 <sup>a</sup> ± 2.4	3 <sup>a</sup> ± 1.3	37 <sup>a</sup> ± 1.4	24 <sup>a</sup> ± 1.9	19 <sup>a</sup> ± 0.6	6.51 <sup>a</sup> ± 2.9

Letter designations indicate significant differences on a horizon basis as determined by ANOVA followed by Tukey's HSD. Different letter designations indicate a p-value of < 0.05.

Table S5 Average relative abundance ± standard error of different carbon compounds in water extracts identified by FT-ICR-MS along upland-to-lowland transects

	Unsaturated Hydro-carbons	Condensed Hydro-carbons	Lipids	Carbo-hydrates	Proteins	Amino Sugars	Lignin	Tannins
<b>Upland</b>								
A	6.4 ± 1.1	11 ± 1.2	32 ± 5.7	9.1 ± 1.8	13 ± 1.9	3.9 ± 1.2	20 ± 2.9	5.2 ± 1.4
B	7.5 ± 1.2	12 ± 1.8	39 ± 6.6	6.2 ± 1.5	11 ± 1.6	2.9 ± 0.8	18 ± 3.2	3.7 ± 1.1
C	6.2 ± 1.5	14 ± 3.2	39 ± 7.1	8.4 ± 2.6	9.4 ± 2.0	3.5 ± 0.7	15 ± 3.1	4.8 ± 0.9
<b>Transition</b>								
A	5.3 ± 0.5	13 ± 1.6	28 ± 3.5	7.8 ± 1.0	14 ± 1.7	4.6 ± 1.0	22 ± 2.4	5.4 ± 0.6
B/C	4.5 ± 0.9	18 ± 2.8	30 ± 3.0	8.0 ± 1.2	8.4 ± 1.4	3.3 ± 0.7	19 ± 2.5	7.6 ± 1.4
Cg	4.3 ± 0.8	17 ± 2.0	35 ± 5.4	6.1 ± 1.4	13 ± 1.9	2.7 ± 1.1	19 ± 3.2	4.2 ± 1.3
<b>Lowland</b>								
A	6.0 ± 0.7	10 ± 1.6	21 ± 2.7	11 ± 1.8	15 ± 1.0	4.9 ± 0.7	27 ± 1.1	5.2 ± 1.3
C	3.7 ± 1.0	21 ± 4.2	24 ± 3.7	8.9 ± 1.7	8.4 ± 1.6	4.1 ± 1.0	22 ± 3.3	9.0 ± 2.1
Cg	5.2 ± 0.4	15 ± 3.1	28 ± 4.0	6.7 ± 0.7	12 ± 1.2	3.6 ± 0.9	24 ± 2.9	5.6 ± 1.5

Table S6 FT-ICR-MS metrics  $\pm$  standard error of water extracts along upland to lowland transects

	Average Peaks	O:C	H:C	DBE	NOSC	AImod	Molecular Weight
<b>Upland</b>							
A	422 $\pm$ 30	0.38 $\pm$ 0.02	1.46 $\pm$ 0.03	3.67 $\pm$ 0.39	-0.60 $\pm$ 0.07	0.16 $\pm$ 0.02	183 $\pm$ 22
B	372 $\pm$ 17	0.34 $\pm$ 0.02	1.51 $\pm$ 0.06	3.19 $\pm$ 0.20	-0.80 $\pm$ 0.12	0.12 $\pm$ 0.01	153 $\pm$ 16
C	392 $\pm$ 32	0.37 $\pm$ 0.03	1.47 $\pm$ 0.06	3.84 $\pm$ 0.38	-0.65 $\pm$ 0.11	0.13 $\pm$ 0.02	158 $\pm$ 27
<b>Transition</b>							
A	744 $\pm$ 180	0.40 $\pm$ 0.02	1.45 $\pm$ 0.03	2.72 $\pm$ 0.33	-0.55 $\pm$ 0.05	0.19 $\pm$ 0.02	211 $\pm$ 22
B/C	385 $\pm$ 55	0.41 $\pm$ 0.02	1.38 $\pm$ 0.04	3.28 $\pm$ 0.34	-0.48 $\pm$ 0.06	0.16 $\pm$ 0.02	177 $\pm$ 25
Cg	783 $\pm$ 278	0.36 $\pm$ 0.03	1.42 $\pm$ 0.05	3.79 $\pm$ 0.59	-0.64 $\pm$ 0.09	0.14 $\pm$ 0.03	157 $\pm$ 23
<b>Lowland</b>							
A	990 $\pm$ 265	0.42 $\pm$ 0.02	1.46 $\pm$ 0.03	3.35 $\pm$ 0.23	-0.56 $\pm$ 0.08	0.23 $\pm$ 0.02	238 $\pm$ 18
C	626 $\pm$ 304	0.44 $\pm$ 0.02	1.32 $\pm$ 0.05	2.91 $\pm$ 0.36	-0.36 $\pm$ 0.09	0.14 $\pm$ 0.02	139 $\pm$ 17
Cg	382 $\pm$ 41	0.39 $\pm$ 0.02	1.42 $\pm$ 0.05	3.40 $\pm$ 0.29	-0.60 $\pm$ 0.09	0.14 $\pm$ 0.01	149 $\pm$ 13

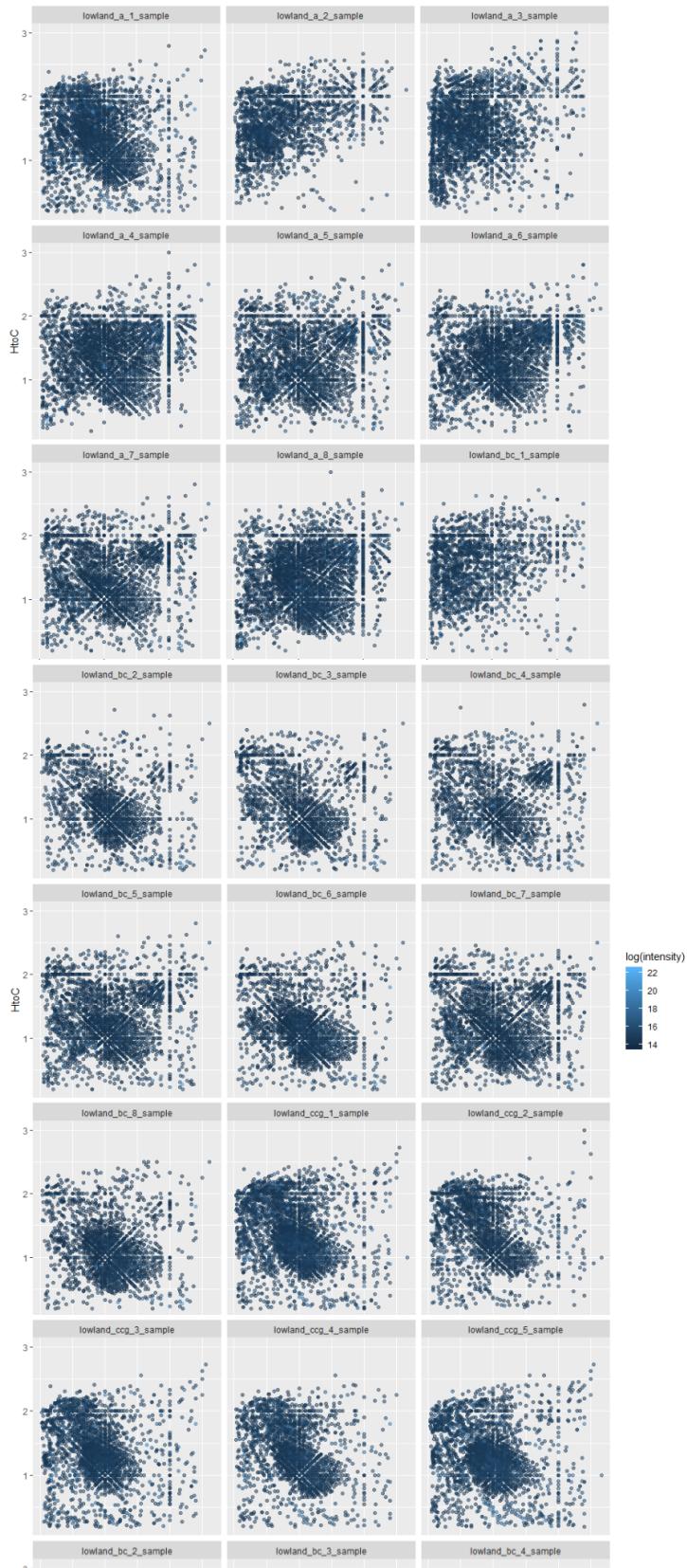


Figure S1

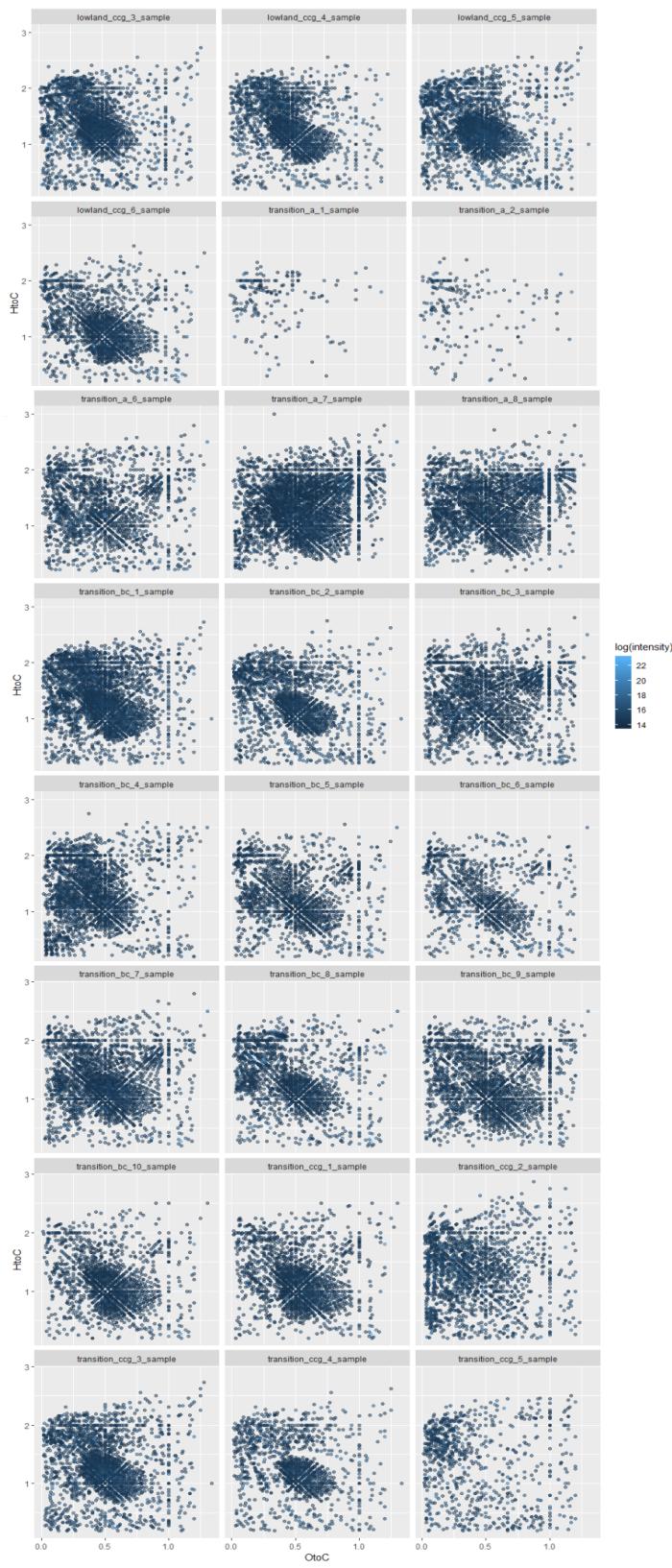


Figure S2

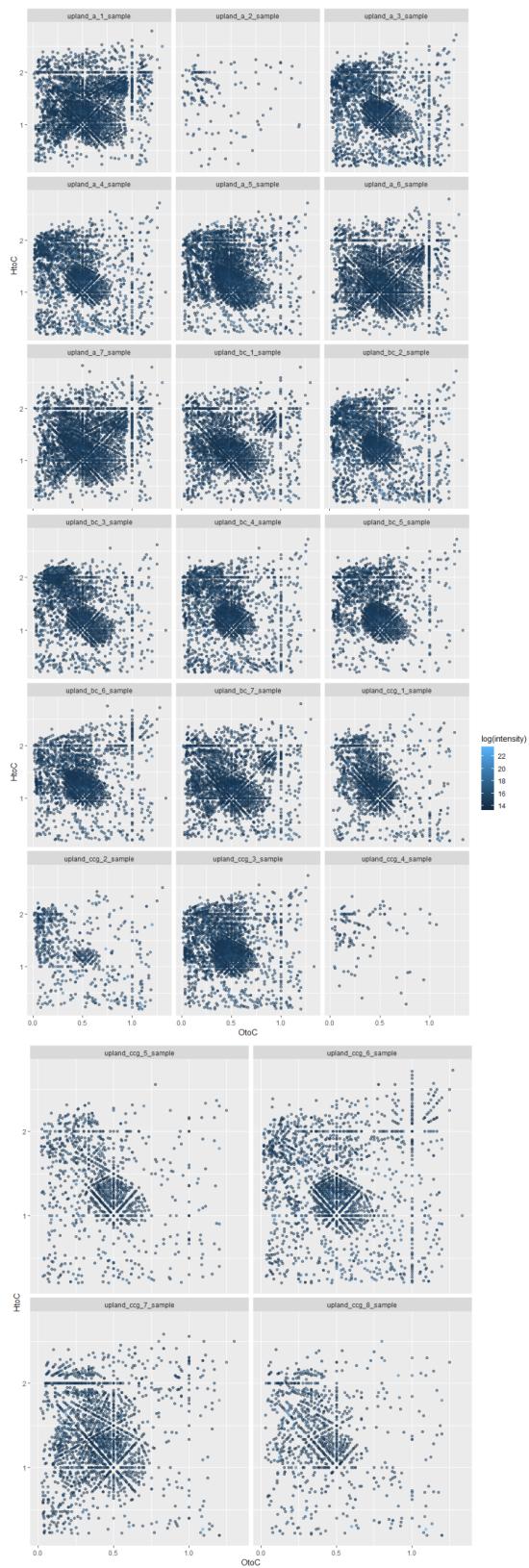


Figure S3