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Supplement of

The net exchange of methane with high Arctic landscapes during the summer growing season

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Supplement

TABLES

Table S1 Meteorological and soil measurements collected by sensors mounted on the eddy covariance towers at the desert and wetland sites.

Meteorological measurements

Air temperature	HMP45C212 temp./humidity probes inside radiation shields
Air pressure	Licor LI-7500 CO ₂ /H ₂ O gas analyzer
Wind speed and direction	Campbell Scientific CSAT3 sonic anemometers
Net, photosynthetically active radiation	Kipp & Zonen net and PAR radiometers
Precipitation	TE525 Tipping Bucket rain gauge

Soil measurements

Soil temperature	CS107B soil temperature probes
Soil moisture	CS616-L soil water content reflectometers
Soil heat flux at 5 cm depth	CSHFT3 soil heat flux plates

Notes: 1. All soil sensors were buried at 5cm depth within 1m of each tower; 2. Precipitation was only periodically monitored during the study period because of high spatial variability and rare measureable events.

Table S2 Spearman rank correlation matrix of daily mean environmental parameters and mean CH₄ fluxes from desert chambers (A.) and wetland chambers (B.) during the 2008-12 growing seasons. Bold indicates statistical significance at $\alpha=0.05$.

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.
A. Desert chambers												
1.CH ₄ NEE	1											-
2.Air pressure	-0.16	1										-
3.Air temperature	-0.02	0.02	1									-
4.Water vapour flux	0.07	-0.02	-0.20	1								-
5.Air density	-0.03	0.48	-0.78	0.02	1							-
6.Soil thaw depth	-0.01	-0.32	0.00	0.46	-0.29	1						-
7.Net radiation	-0.13	-0.04	0.06	-0.16	0.02	-0.43	1					-
8.PAR	-0.28	-0.07	0.20	-0.27	-0.08	-0.46	0.93	1				-
9.Soil heat flux (5 cm)	-0.14	-0.24	0.37	-0.20	-0.34	-0.09	0.65	0.71	1			-
10.Soil moisture	-0.20	0.06	-0.02	-0.27	0.07	-0.43	0.40	0.39	0.35	1		-
11.Soil temperature	0.01	0.13	0.84	-0.26	-0.50	-0.36	0.21	0.38	0.41	0.16	1	-
B. Wetland chambers												
1.CH ₄ NEE	1											
2.Air pressure	-0.26	1										
3.Air temperature	0.08	-0.33	1									
4.Water vapour flux	0.36	-0.01	0.13	1								
5.Air density	-0.12	0.69	-0.88	0.01	1							
6.Soil thaw depth	0.51	-0.48	-0.04	0.53	-0.11	1						
7.Net radiation	-0.53	0.27	0.54	-0.38	-0.37	-0.61	1					
8.PAR	-0.52	0.29	0.53	-0.41	-0.35	-0.66	0.99	1				
9.Soil heat flux (5 cm)	-0.52	0.32	0.38	-0.52	-0.16	-0.58	0.80	0.81	1			
10.Soil moisture	0.34	0.25	0.06	-0.04	0.05	0.21	0.17	0.14	-0.03	1		
11.Soil temperature	0.22	0.06	0.47	-0.20	-0.35	-0.23	0.51	0.49	0.31	0.66	1	
12.Stream discharge	0.72	-0.20	0.05	0.53	-0.04	0.77	-0.43	-0.47	-0.51	0.50	0.23	1

Table S3 Spearman rank correlation matrix of environmental factors and mean EC CH₄ fluxes from wetland LI-7700 measurements during the 2012 growing season. Bold indicates statistical significance at $\alpha=0.05$.

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.
EC measurements	1. CH ₄ NEE	1												
	2. Momentum flux	0.35	1											
	3. Sensible heat flux	0.09	0.32	1										
	4. Latent energy flux	0.22	0.40	0.59	1									
	5. CO ₂ flux	-0.71	-0.01	0.19	0.03	1								
	6. Water vapour flux	0.21	0.39	0.59	1.00	0.03	1							
	7. Friction velocity	0.36	0.99	0.30	0.39	0.00	0.39	1						
Other measurements	8. Net radiation	-0.38	0.20	0.73	0.49	0.60	0.49	0.18	1					
	9. PAR	0.00	0.26	0.79	0.74	0.14	0.74	0.24	0.80	1				
	10. Soil heat flux (5cm)	0.03	-0.11	0.11	0.25	-0.04	0.25	-0.15	0.29	0.33	1			
	11. Soil moisture	0.09	0.46	0.37	0.38	0.31	0.37	0.52	0.26	0.21	-0.48	1		
	12. Soil temperature	0.65	0.18	0.15	0.53	-0.58	0.53	0.17	-0.22	0.28	0.09	0.12	1	
	13. Air pressure	-0.36	-0.19	0.35	0.05	0.39	0.06	-0.22	0.54	0.44	0.47	-0.26	-0.21	1
	14. Air temperature	0.49	0.25	0.18	0.70	-0.43	0.70	0.27	-0.03	0.45	0.17	0.29	0.82	-0.27

Table S4 Summary table of site mean CH₄ fluxes (F_{CH₄}) measured in high-, low- and subarctic tundra (as defined by AMAP, 1998) for some portion of the northern growing season (May-October). Fluxes organized by chamber and eddy covariance measurements and by terrestrial sites predominantly emitting or consuming CH₄. All fluxes in mg CH₄ m⁻² d⁻¹.

Location	Lat Lon	LANDSCAPE / METHOD				Reference
		Emission Sites		Consumption Sites		
		Chambers	Eddy Cov.	Chambers	Eddy Cov.	
<u>High Arctic</u>						
Ellesmere I., CA	81°49' -71° 20'	0.2	1.3	-1.4		<i>This study</i>
Ellesmere I., CA	77-82° -63-75			-0.9 – -0.3		1-2
Zackenbergl, GL	74°28' -20° 34'	71 – 202	40 – 90	-0.3		3-8
Northern RU	72-73° 140-143°	0.1 – 78				9
<u>Low Arctic</u>						
Lena Delta, RU	72°22' 126° 30'	16 – 55	19 – 30			10-13
Tiski, RU	71°30' 130° 00'	23				14
Barrow, US	71°17' -156° 41'	23 – 52	32			15-18
Alaska, US	68-71° -148-158°	49 – 5				19,20
Toolik, US	68°38' -149° 38'	5 – 78				21-26
Yamal, RU	68°08' 71° 42'	58				27
Northern RU	67-77° 40-179°	27		-0.5		11
Vorkuta, RU	67°20' 63° 44'	5-83				28,29
Daring Lake, CA	64°52' -111° 35'	62				30
Bethel, US	60°45' -161° 45'	96	20			31,32
Churchill, CA	58°45' -94° 09'	54				33
Skan Bay, US	53° 39' -167° 04'			-3		34
<u>Sub Arctic</u>						
Indigirka, RU	70°49' 147° 29'	103	63			35,36
Cherskii, RU	69°36' 161° 20'	165-281		-1		14,37,38
Kaamanen, FI	69°08' 27° 16'	68	29			39,40
Stordalen, SE	68°21' 19° 02'	10-203	28-38	-1		41-47
Schefferville, CA	54°47' -66° 49'	30		-3		48,49
James Bay, CA	51°31' -80° 27'	16-52				33,50

1-Lamb et al., 2011

2-Stewart et al., 2012

3-Christensen et al., 2000

4-Mastepanov et al., 2008

5-Ström et al., 2012

6-Joabsson and Christensen, 2001

7-Tagesson et al., 2012

8-Friborg et al., 2000

9-Christensen et al., 1995

10-Kutzbach et al., 2004

11-Sachs et al., 2008

12-Sachs et al., 2010

13-Wille et al., 2008

14-Nakano et al., 2000

15-Lara et al., 2012

16-Rhew et al., 2007

17-Sturtevant et al., 2012

18-von Fischer et al., 2010

19-Morrissey and Livingston, 1992

20-Sebacher et al., 1986

21-King et al., 1998

22-Moosavi & Crill, 1998

23-Schimel, 1995

24-Torn and Chapin, 1993

25-Verville et al., 1998

26-Oberbauer et al., 1998

27-Heyer et al., 2002

28-Berestovakaya et al., 2005

29-Heikkinen et al., 2002a

30-Wilson & Humphreys, 2012

31-Bartlett et al., 1992

32-Fan et al., 1992

33-Roulet et al., 1994

34-Whalen & Reeburgh, 1990

35-Parmentier et al., 2011

36-van Huissteden et al., 2005

37-Merbold et al., 2009

38-Corradi et al., 2005

39-Hargreaves et al., 2001

40-Heikkinen et al., 2002b

41-Friborg et al., 1997

42-Jackowicz-Korczynski et al., 2010

43-Oquist and Svensson, 2002

44-Ström et al., 2007

45-Svensson and Rosswell, 1984

46-Svensson et al., 1999

47-Christensen et al., 1997

48-Bubier, 1995

49-Adamsen & King, 1993

50-Moore et al., 1994

Table S5 Concentrations ($\pm 1SD$) of several chemicals downstream through the Skeleton Creek wetland complex. All chemicals are reported in $\mu\text{mol L}^{-1}$.

	Location	Dissolved CH_4	Dissovled CO_2	Water_T	$\text{NO}_3^-:\text{NH}_4^+$	DIN:TDN	DOC	PN	Ca^{2+}
← Downstream	PF-1	0.00 \pm 0.00	40 \pm 1	4 \pm 1	205	1.0	67	0.08	3.1
	PF-2	0.00 \pm 0.01	45 \pm 9	11 \pm 2	-	-	-	-	-
	Skeleton	0.18 \pm 0.22	23 \pm 9	12 \pm 3	0.14 \pm 0.20	0.03 \pm 0.02	425 \pm 100	0.05 \pm 0.02	1.4 \pm 0.5
	Pond 11	0.04 \pm 0.02	25 \pm 8	14 \pm 2	0.20 \pm 0.66	0.03 \pm 0.02	389 \pm 13	0.04 \pm 0.02	2.2 \pm 0.6
	Stream-1	0.03 \pm 0.02	106 \pm 35	12 \pm 2	-	-	-	-	-
	Stream-2	0.00 \pm 0.00	69 \pm 21	12 \pm 2	-	-	-	-	-
	Wet-In	0.01 \pm 0.01	80 \pm 41	9 \pm 2	0.11 \pm 0.14	0.04 \pm 0.03	471 \pm 48	0.03 \pm 0.04	3.0 \pm 0.5
	Wet-Out	0.00 \pm 0.01	77 \pm 24	9 \pm 2	0.07 \pm 0.13	0.04 \pm 0.02	524 \pm 47	0.05 \pm 0.05	3.0 \pm 0.5

Water_T: water temperature; *NO₃⁻*: dissolved nitrate; *NH₄⁺*: dissolved ammonium; *DIN*: dissolved inorganic nitrogen; *TDN*: total dissolved nitrogen; *DOC*: dissolved organic carbon; *PN*: particle-bound nitrogen; *Ca²⁺*: dissolved calcium

FIGURES

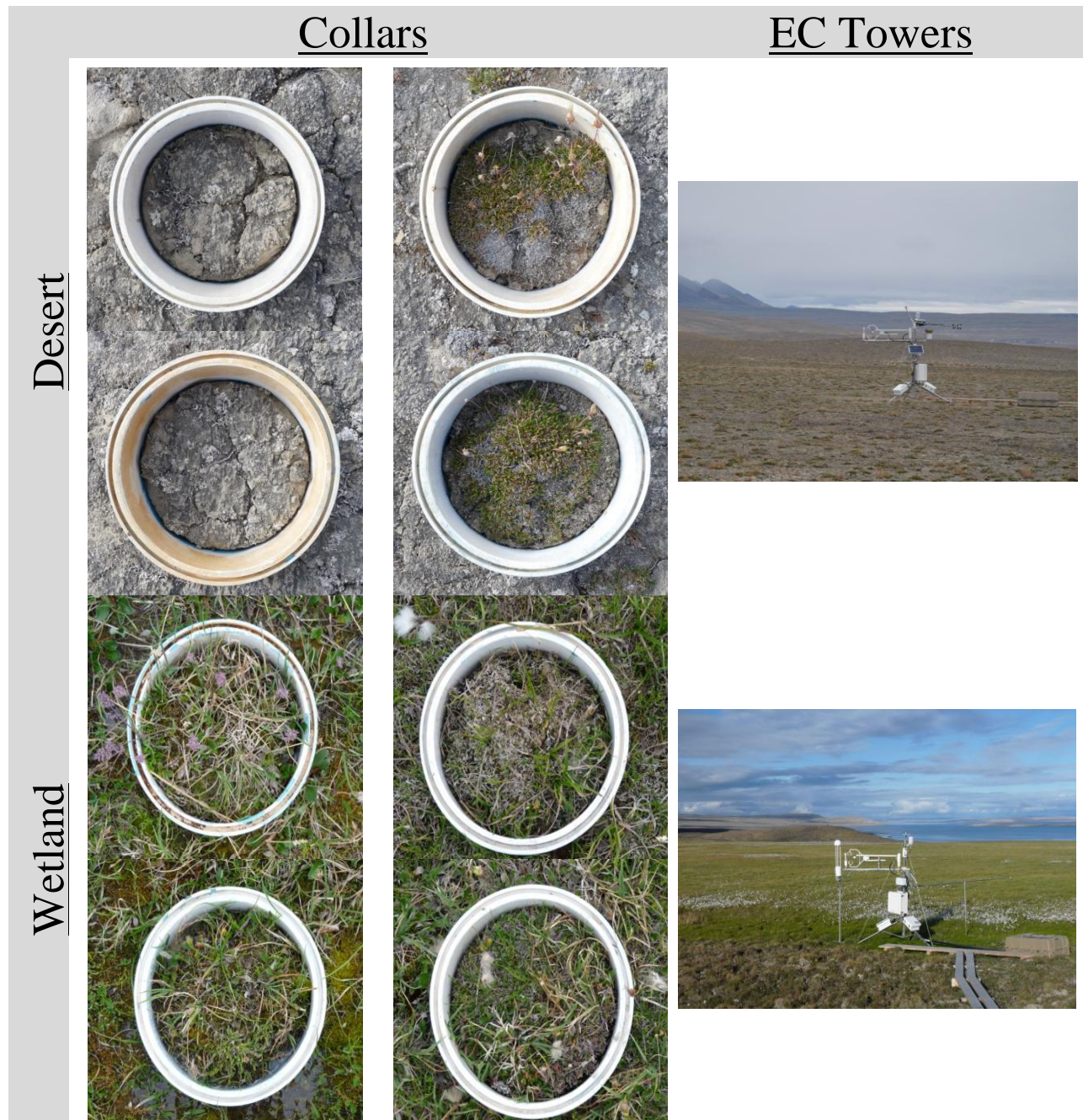


Figure S1 Photos of all chambers and enclosed vegetation, and EC towers and footprints at the desert and wetland sites. Photos taken during the growing season (*photos by C. Emmerton*).

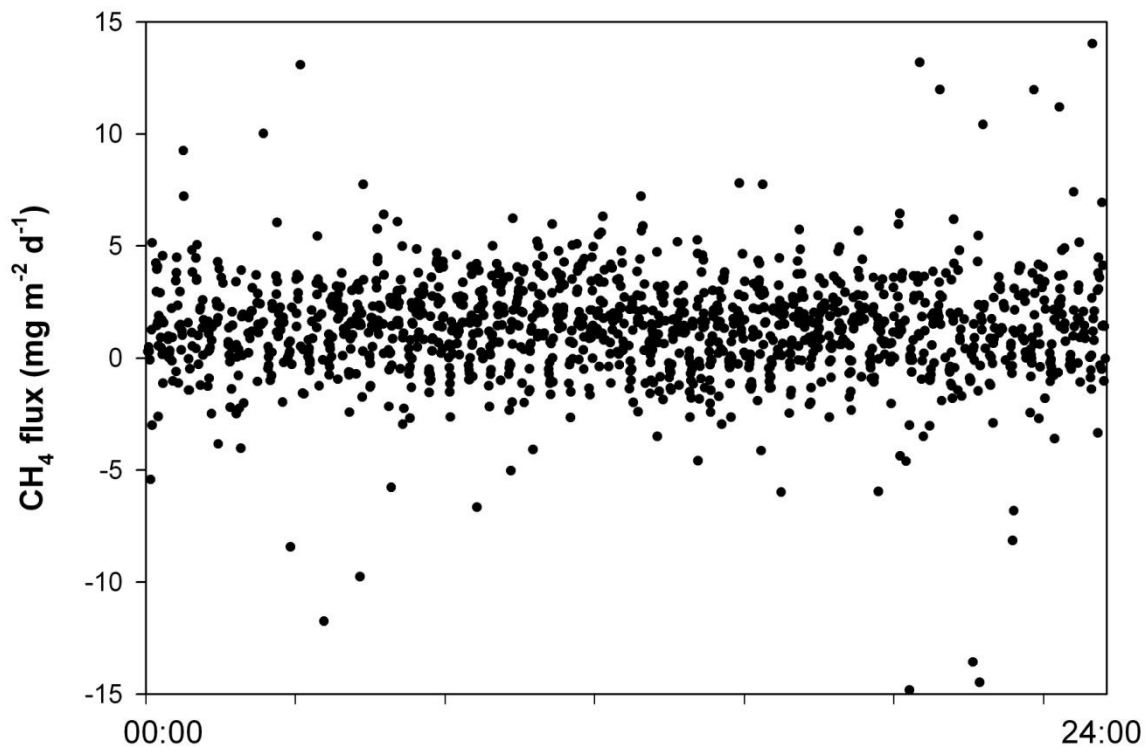


Figure S2 Diurnal organization of all half-hourly CH₄ fluxes for the 2012 growing season at the wetland as measured by the EC tower.

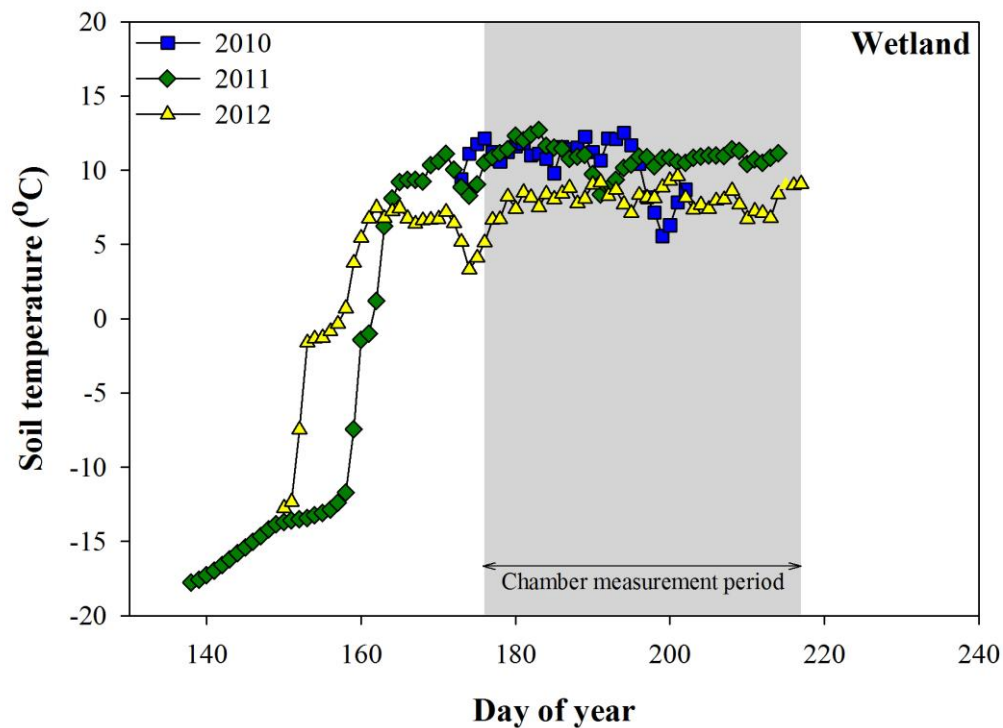
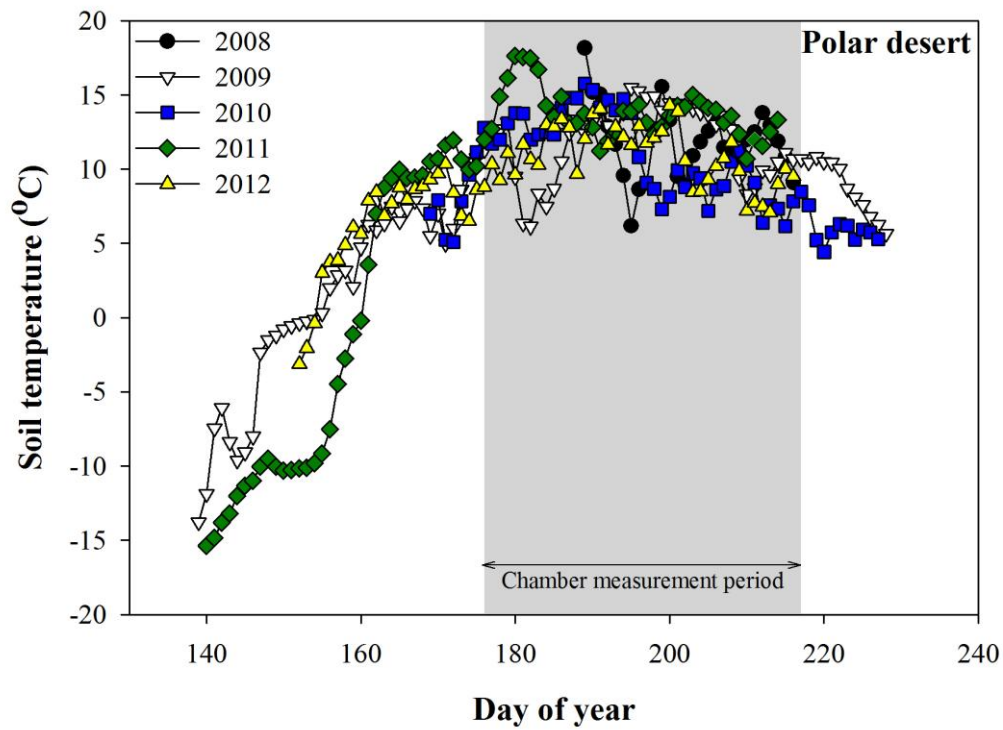


Figure S3 Soil temperatures at 5 cm depth during the growing seasons of 2008 to 2012 at the desert (upper) and wetland (lower) eddy covariance flux towers.

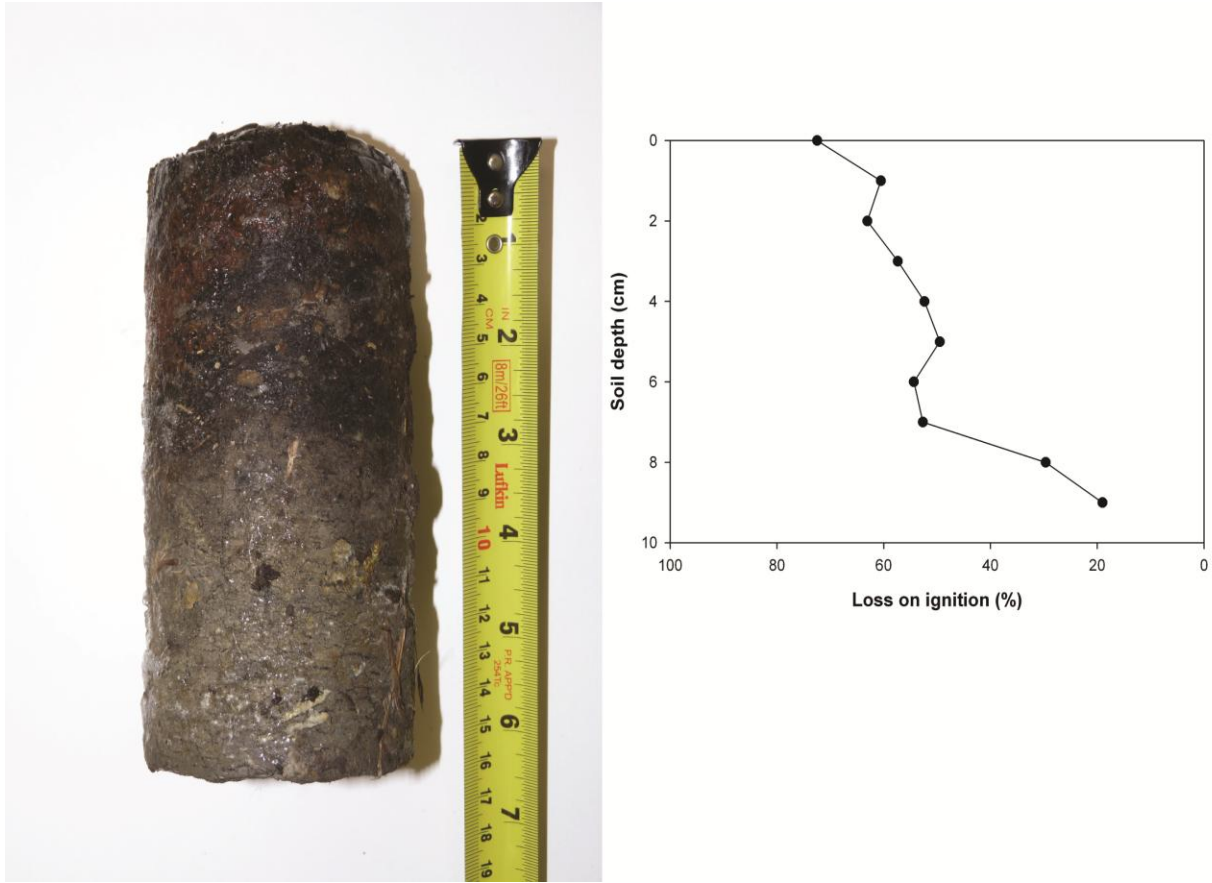


Figure S4 Photograph of a soil core extracted from the approximate middle of the wetland in May 2011 during frozen conditions (left panel). Graph of loss of ignition values (550°C) by depth for 0.5 cm portions of the wetland core (right panel) (*photo by C. Emmerton*).

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