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Impacts of temperature and soil characteristics on methane production and oxidation in Arctic tundra

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Table S1. Physicochemical characteristics of soils from FCP and HCP

	Depth (cm)	Horizon	Water content (g g-1)	pH (KCl)	Fe(II) umol g soil	Total C (%)	C:N
FCP	10-30	Organic	0.44	4.24	9.72	18.56	18
	40-50	Transition	2.48	4.86	50.20	5.80	16
	50-70	Permafrost	3.95	4.95	68.95	30.83	18
HCP	10-30	Organic	0.67	4.70	14.36	20.49	21
	50-70	Permafrost	4.43	5.72	79.37	17.10	21

Table S2. Fitted parameters for CH_4 production with linear model *(C=A×t+B)*.

Horizon	**Temperature**	**model**	**A**	**B**	**R^2**
FCP Transition	+8	Linear	0.0685	0.0372	0.94
	+4	Linear	0.0427	0.2133	0.81
	-2	Linear	0.0166	0.1751	0.92
FCP Permafrost	+8	Linear	0.0074	0.1039	0.79
	+4	Linear	0.0060	0.0758	0.76
	-2	Linear	0.0043	0.0895	0.73

Table S3. Fitted parameters for CO_2 production with Hyperbolic *($C=A\times t/(B+t)$),* Linear *($C=A\times t+B$)*, and Sigmoidal ($C=A\times t^d/(B^d+t^d)$) models.

Horizon	**Temperature**	**model**	**A**	**B**	**d**	**R^2**
FCP Organic	+8	Hyperbolic	545.19	53.60	-	0.85
	+4	Hyperbolic	1588.17	545.18	-	0.91
	-2	Linear	1.70	6.96	-	0.95
FCP Transitional	+8	Hyperbolic	32.18	13.30	-	0.82
	+4	Hyperbolic	28.35	16.11	-	0.78
	-2	Hyperbolic	12.09	2.82	-	0.47
FCP Permafrost	+8	Hyperbolic	48.52	14.63	-	0.84
	+4	Hyperbolic	67.51	38.05	-	0.67
	-2	Hyperbolic	45.80	32.55	-	0.87
HCP Organic	+8	Sigmoidal	31.12	57.19	1.85	0.96
	+4	Sigmoidal	17.10	44.42	2.32	0.87
	-2	Sigmoidal	6.48	33.48	5.12	0.91
HCP Permafrost	+8	Sigmoidal	3.69	50.56	25.43	0.90
	+4	Sigmoidal	3.81	52.71	18.00	0.81
	-2	Sigmoidal	1.93	51.50	10.48	0.98

Table S4. Temperature sensitivities of soil anaerobic respiration and methanogenesis from FCP transition zone and permafrost

		CO_2				CH_4	
Horizon	T (°C)	Rate[a] (μmol g^{-1} day^{-1}) Linear fitting	Q_{10}	Rate[b] (μmol g^{-1} day^{-1}) Hyperbolic fitting	Q_{10}	Rate (μmol g^{-1} day^{-1})	Q_{10}
FCP Transition	-2	0.49	**1.3**	1.82	**1.2**	0.0166	**4.1**
	4	0.48		1.66		0.0427	
	8	0.64		2.25		0.0685	
FCP Permafrost	-2	0.40	**3.3**	1.37	**2.3**	0.0043	**1.7**
	4	1.00		1.73		0.0060	
	8	1.31		3.10		0.0074	

Table S5. Concentrations of Organic Acids* from FCP Transitional and Permafrost Layers.

		FCP Transitional			FCP Permafrost		
	Incubation days	-2°C	4°C	8°C	-2°C	4°C	8°C
Formate	0		0.68			1.68	
	20	0.77	0.72	0.86	1.56	1.43	1.96
	90	0.48±0.06	0.52 ±0.02	0.44 ±0.07	0.99±0.2	1.04±0.24	1.14±0.05
Acetate	0		1.28			10.97	
	20	1.44	1.76	1.89	10.95	9.78	12.94
	90	2.00±0.44	3.10±0.02	3.27±0.07	12.79±1.18	15.29±0.75	16.78±2.92
Propionate	0		0.49			3.82	
	20	0.53	0.65	0.62	3.73	2.97	3.82
	90	0.51±0.12	0.51±0.03	0.39±0.06	8.9±0.33	8.8±0.18	10.1±0.41
Butyrate	0		0.10			1.74	
	20	0.12	0.16	0.20	1.87	1.64	2.13
	90	0.08±0.02	0.15±0.01	0.11±0.03	1.92±0.11	2.11±0.07	2.17±0.13
Oxalate	0		0.09			0.23	
	20	0.12	0.14	0.16	0.28	0.31	0.34
	90	0.10±0.02	0.11±0.00	0.08±0.01	0.23±0.03	0.24±0.03	0.26±0.01

*Results are presented in μmol g^{-1} (on per gram soil dry weight basis). The average and standard deviation are shown for triplicate soil samples incubated for 90 days.

Figure S1. Geochemical properties of divided soil layers from (a) FCP and (b) HCP. Measured Fe(II) concentrations and soil porewater dissolved CH_4 concentrations are plotted and data points corresponding to soil segments used for incubations are circled in red.

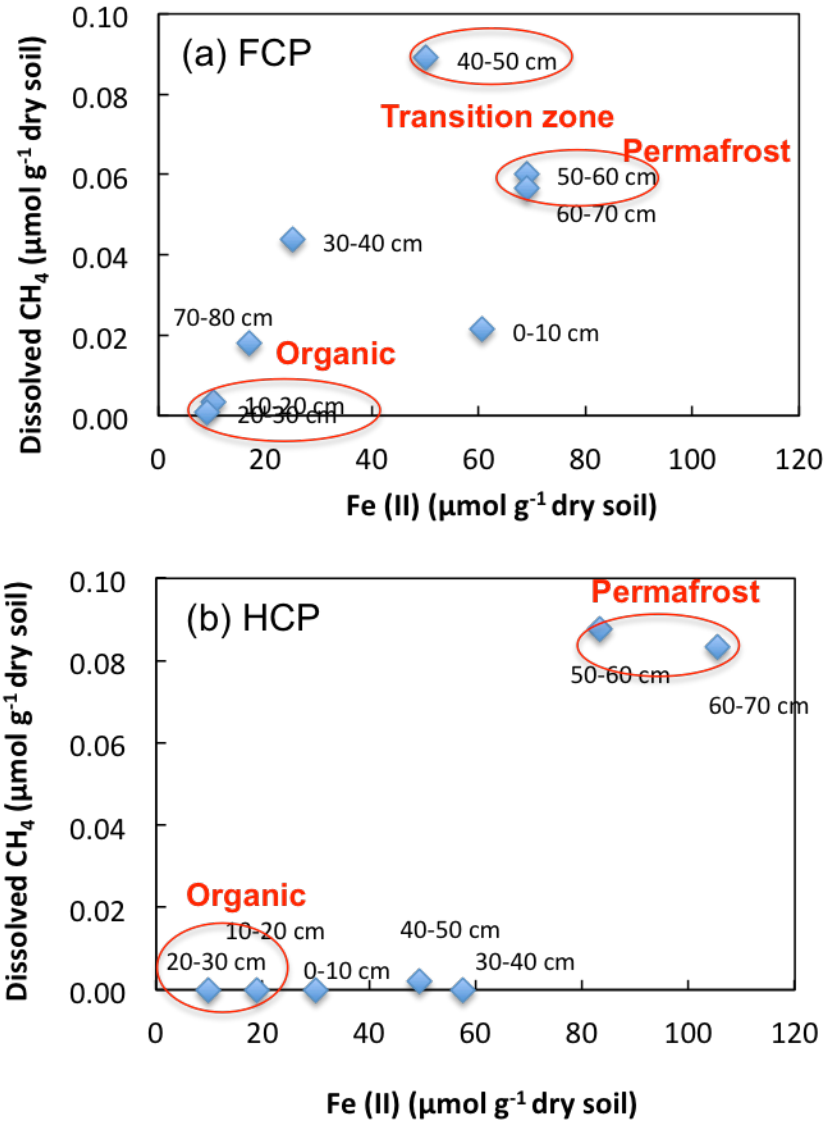

Figure S2. CH_4 production in soil microcosm from active and permafrost horizons of HCP, and active horizon of FCP.