



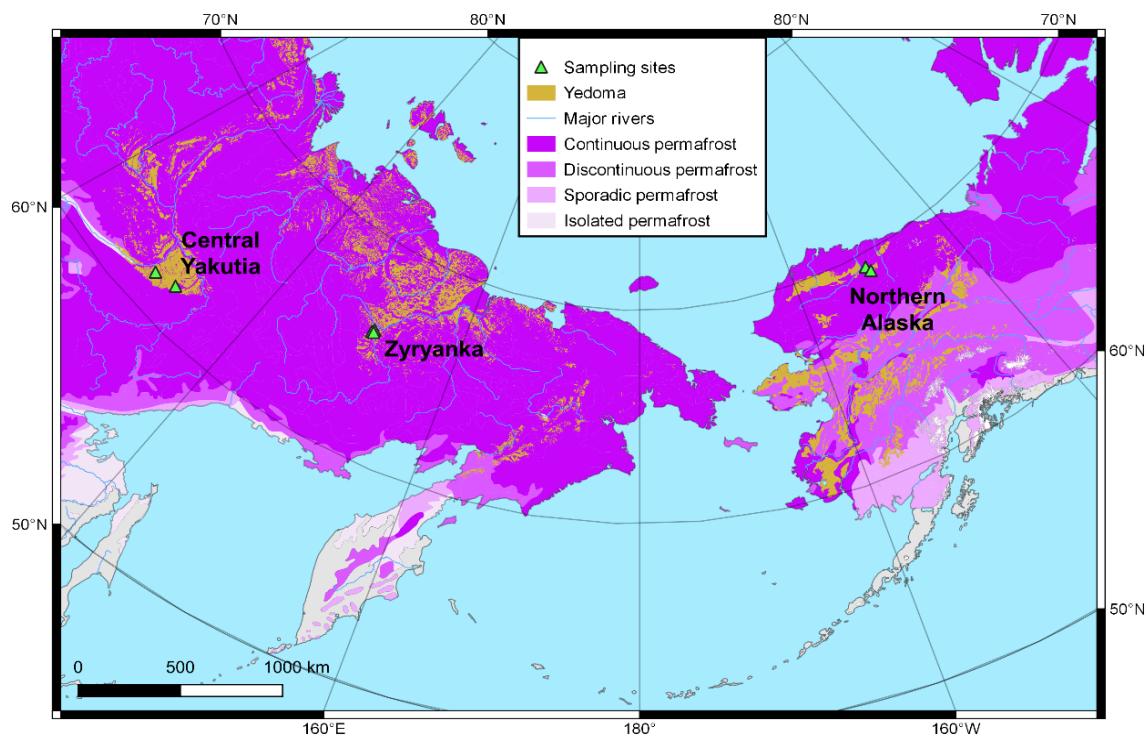
*Supplement of*

**Brief Communication: The reliability of gas extraction techniques for analysing CH<sub>4</sub> and N<sub>2</sub>O compositions in gas trapped in permafrost ice wedges**

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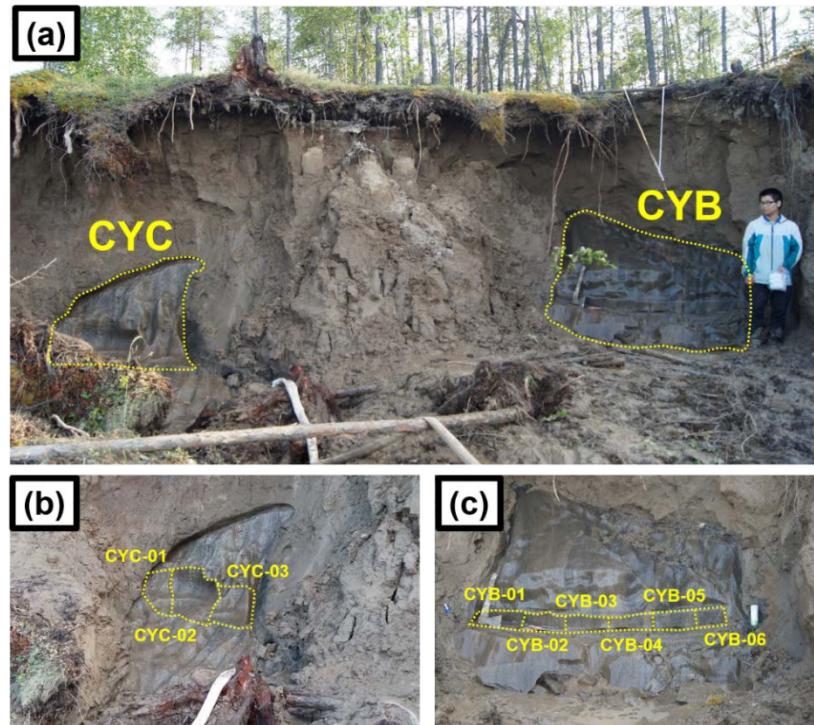
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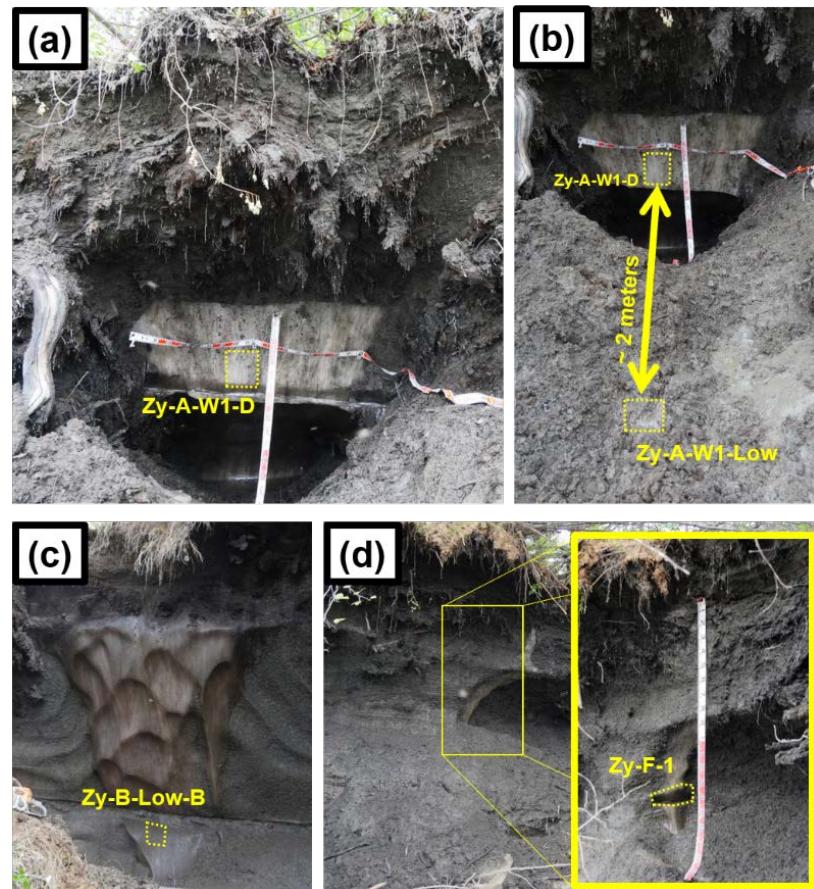
**Figure S1.** The site locations of the ground ice samples used in this study are marked in the map of circum-Arctic permafrost (Brown et al., 2002), Yedoma distributions (Strauss et al., 2016), and major rivers.



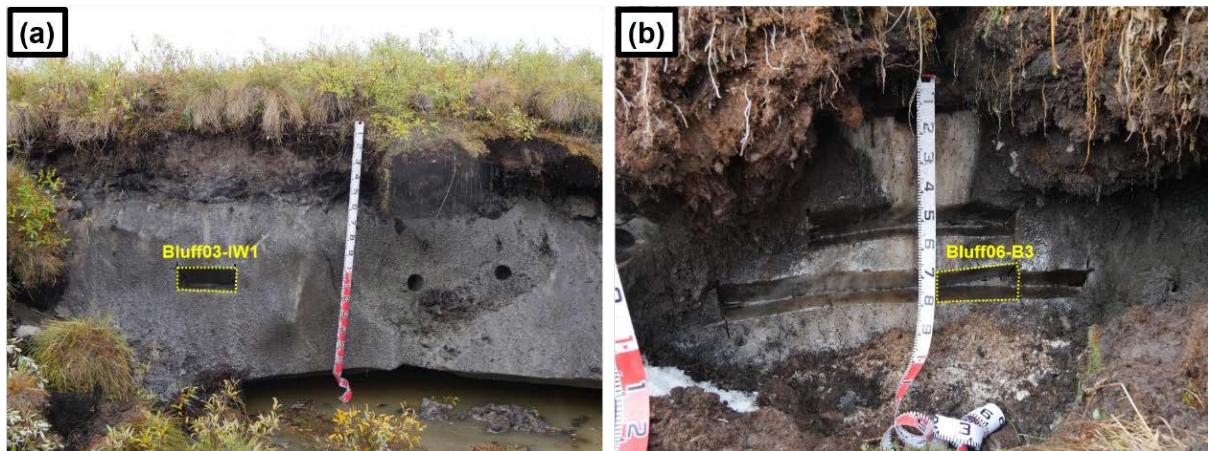
**Figure S2.** Images of ground ice outcrops at Churapcha (central Yakutia) site. Locations of the samples used in this study are indicated by yellow dotted circles.



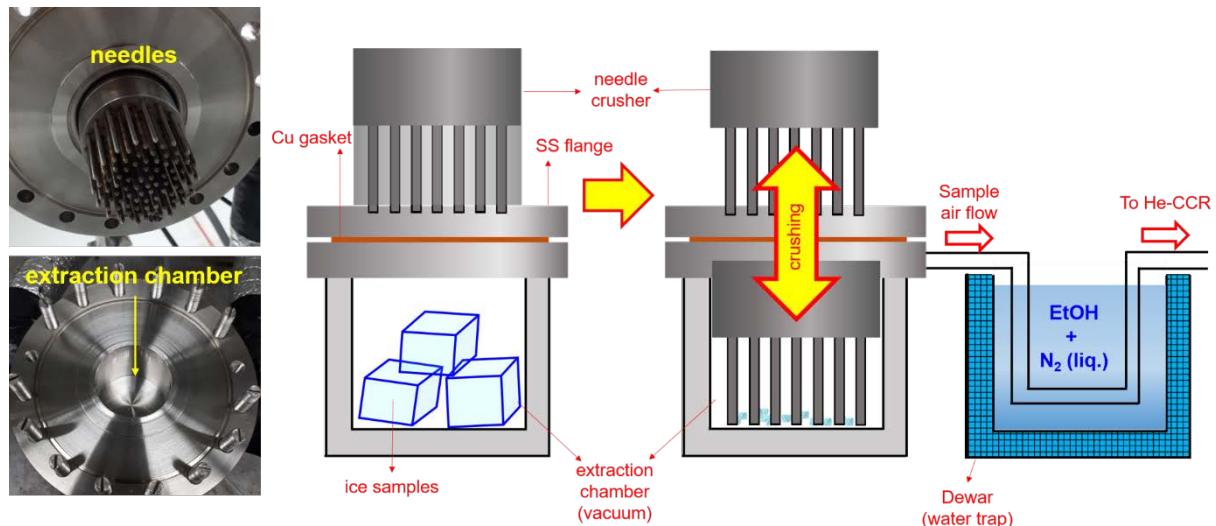
**Figure S3.** Images of ground ice outcrops at Cyuie (central Yakutia) sites: (a) ice wedge outcrop, (b) CYC and (c) CYB samples. Locations of the samples used in this study are indicated by yellow dotted lines.



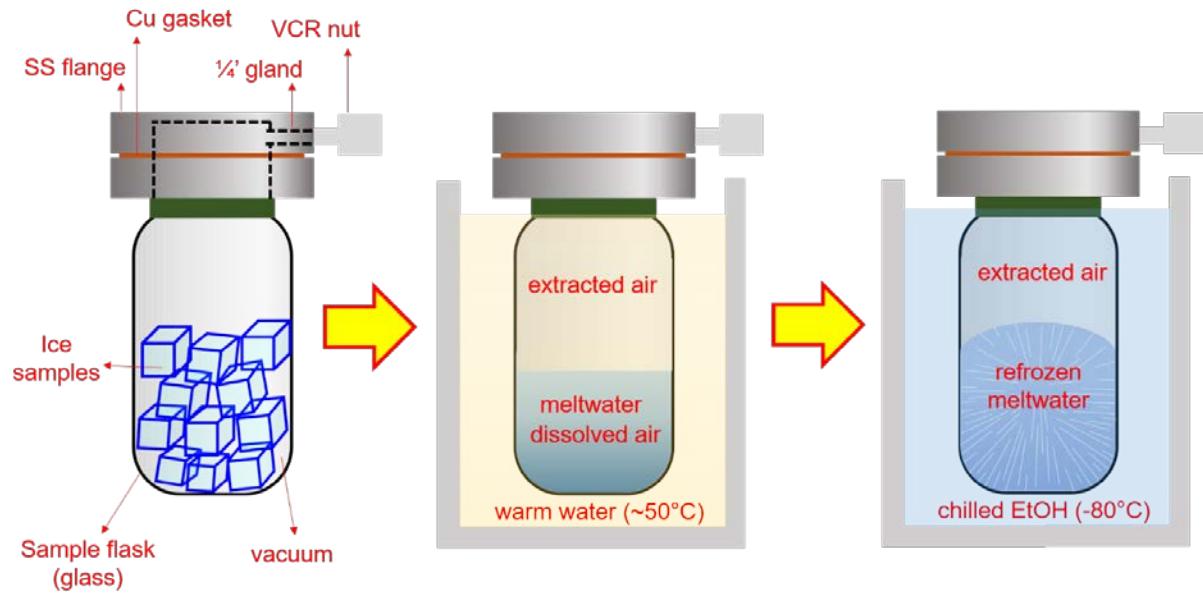
**Figure S4.** Images of ground ice outcrops at Zyryanka sites: (a and b) Zy-A, (c) Zy-B, and (d) Zy-F. Locations of the samples used in this study are indicated by yellow dotted lines.



**Figure S5.** Images of ground ice outcrops at northern Alaskan sites: (a) Bluff03 and (b) Bluff06. Locations of the samples used in this study are indicated by yellow dotted boxes.



**Figure S6.** Schematic diagram of needle-crusher method together with enlarged photographs of crushing needles (left top), and extraction chamber (left bottom). The detailed descriptions about the SNU dry extraction system can be found elsewhere in Ahn et al. (2009) and Shin (2014).



**Figure S7.** Schematic diagram of melting-refreezing (wet extraction) procedure used in this study. More details about the wet extraction line and GC systems are described in Yang et al. (2017) and Ryu et al. (2018).

**Table S1.** Comparison of CH<sub>4</sub> and N<sub>2</sub>O results from extracted gas from control wet extraction method and the dry (hit5) extraction method plotted in Figures 1(a to d).

Site Location	Sample	soil content	wet-control CH <sub>4</sub>		dry-hit5 CH <sub>4</sub>		wet-control N <sub>2</sub> O		dry-hit5 N <sub>2</sub> O	
		wt. %	ppm	nmol/kg	ppm	nmol/kg	ppm	nmol/kg	ppm	nmol/kg
Zyryanka, Northeastern Siberia	Zy-F-1	0.618	1080	651	655.6	316	1.57	0.946	2.81	1.02
	Zy-B-Low-B	0.107	18030	23400	21010	29900	5.37	6.97	5.32	5.68
	Zy-A-W1-Low	0.049	4309	5890	5073	8390	2.07	2.83	0.69	0.85
	Zy-A-W1-D	0.155	6138	5530	3713	2890	11.37	10.3	9.10	5.32
Northern Alaska	Bluff06-B3	0.078	558.7	678	164.2	204	3.74	3.36	18.78	17.5
Cyuie, Central Yakutia	CYB-04-C	0.498	20.2	25.5	48.4	88.3	0.71	0.67	0.65	0.90
	CYB-03-A	0.423	20.4	24.0	21.5	30.5	0.91	0.80	1.01	1.07
	CYB-06-A	0.387	35.0	52.0	15.5	21.2	0.65	0.66	0.53	0.54
	CYB-05-C	1.20	19.4	23.4	13.1	21.8	1.01	0.906	0.88	1.1
	CYB-02-D	0.287	7.4	13	9.2	11	13.53	12.4	0.27	0.25
	CYB-04-D	0.345	10.5	17.7	10.3	15.8	3.94	4.94	0.44	0.51
	CYB-04-A	0.618	7.1	12	7.1	4.9	0.82	0.99	0.68	0.35
	CYC-01-B	0.252	18.0	20	18.3	23.6	1.55	1.25	1.60	1.55
	CYC-02-A	0.418	8.0	13	8.3	10	0.75	0.82	0.52	0.49
	CYC-03-B	0.836	14.0	22.6	17.8	24.5	1.41	1.61	0.75	0.77
	CYC-01-C	0.374	13.9	19.0	17.4	18.1	0.70	0.72	0.67	0.52
	CYC-03-C	1.08	30.9	37.5	32.5	32.5	0.52	0.55	0.74	0.55
	CYC-02-B	1.12	30.3	44.0	12.1	13.0	8.34	9.37	0.34	0.28
	CYC-02-C	0.306	119.0	132	5.9	6.2	0.66	0.55	0.57	0.44
	CYC-02-D	0.572	29.4	34.1	29.8	18.6	1.53	1.33	0.25	0.12
Churapcha, Central Yakutia	C04	1.38	7.0	14	9.2	14	43.46	66.7	34.36	38.2
	C07	0.328	4.9	10	4.8	11	NA	NA	NA	NA
	C08	0.620	5.3	8.9	5.0	7.8	42.08	53.2	76.47	90.5
	C10	0.269	5.5	9.3	7.1	14	61.13	82.4	48.12	71.3
	C12	0.253	3.2	5.4	4.4	5.5	60.47	79.8	58.55	55.7
	C18	0.582	3.4	4.9	4.6	7.9	15.84	17.2	19.40	24.9
	C19	0.433	3.3	4.7	4.6	10	NA	NA	NA	NA
	C30	1.03	4.4	8.2	5.7	10	22.28	31.2	14.14	18.7

**Table S2.** Comparison of CH<sub>4</sub> and N<sub>2</sub>O results from extracted gas from control wet extraction and HgCl<sub>2</sub>-treated wet extraction method plotted in Figures 1(e to f).

Site Location	Sample	soil content	Wet-control CH <sub>4</sub>	Wet-HgCl <sub>2</sub> CH <sub>4</sub>	Wet-control N <sub>2</sub> O	Wet-HgCl <sub>2</sub> N <sub>2</sub> O
		wt. %	ppm	ppm	ppm	ppm
Zyryanka, Northeastern Siberia	Zy-A-W1-D	0.155	6138	2605	11.37	15.25
	Zy-B-Low-D	0.251	10620	7355	2.14	1.447
	Zy-A-W1-Low	0.049	4309	4449	2.07	2.261
	Zy-F-1	0.618	1080	1427	1.57	2.069
	Zy-B-Low-B	0.107	18030	22780	5.37	5.331
Northern Alaska	Bluff06-B3	0.078	558.7	422.1	3.74	10.26
	Bluff06-B1	0.077	2003	1741	1.13	1.248
	Bluff03-IW1	2.07	44160	18540	5.58	1.788
	Bluff06-B2	0.007	589.2	808.1	1.32	2.026
Cyuie, Central Yakutia	CYB-01-A	0.700	17.3	16.97	0.94	0.842
	CYB-04-A	0.618	7.1	7.52	0.81	0.799
	CYB-04-C	0.498	20.2	16.71	0.71	0.767
	CYC-01-B	0.252	18.0	4.76	1.55	0.544
	CYC-02-C	0.306	119.0	9.83	0.66	0.791
	CYC-02-D	0.572	29.4	29.30	1.53	1.193

### **References not cited in main text**

Brown, J., Ferrians Jr., O. J., Heginbottom, J. A., and Melnikov, E.: Circum-Arctic map of permafrost and ground-ice conditions, version 2, National Snow and Ice Data Center, Boulder, CO, 2002.

Strauss, J., Laboor, S., Fedorov, A. N., Fortier, D., Froese, D., Fuchs, M., Grosse, G., Günther, F., Harden, J. W., Hugelius, G., Kanevskiy, M. Z., Kholodov, A. L., Kunitsky, V. V., Kraev, G., Lapointe-Elmrabti, L., Lozhkin, A. V., Rivkina, E., Robinson, J., Schirrmeyer, L., Shmelyov, D., Shur, Y., Siegert, C., Spektor, V., Ulrich, M., Vartanyan, S. L., Veremeeva, A., Walter Anthony, K. M., and Zimov, S. A.: Database of Ice-Rich Yedoma Permafrost (IRYP), PANGAEA, <https://doi.org/10.1594/PANGAEA.861733>, 2016.