

Table 1. Endmember means \pm standard deviations and sample numbers (n) used in the three tracer MixSIAR models. For endmember value sources see Supporting Information.

Endmember	$\Delta^{14}\text{C}$ (‰)	$\delta^{13}\text{C}$ (‰)	C:N	n ($\Delta^{14}\text{C}$)	n ($\delta^{13}\text{C}$)	n (C:N)
Aquatic biomass ^a	-106.4 \pm 163.8	-33.1 \pm 4.7	9.5 \pm 3.3	78	132	36
Fresh terrestrial production ^a	97.0 \pm 124.8	-27.7 \pm 1.3	91.7 \pm 51.1	58	40	58
Shallow soil ^a	-228.3 \pm 211.2	-27.8 \pm 1.7	21.4 \pm 16.9	308	130	184
Deep soil ^a	-491.6 \pm 172.8	-27.7 \pm 1.4	24.0 \pm 26.4	287	126	137
Yedoma ^b	-954.6 \pm 66.4	-26.8 \pm 2.3	8.6 \pm 3.0	214	48	135
Petrogenic ^c	-1000.0 \pm 0.0	-24.4 \pm 2.4	14.3 \pm 0.0	5	10	1

^aendmember used in every river model

^bendmember used only in the Lena, Kolyma, and Yukon models

^cendmember used only in the Mackenzie model

Table 2. Mean (standard error) fluxes of endmembers for each river averaged across 8 years (except for the Mackenzie, where they are averaged across 6 years) using median (50%CI) endmember contributions. All fluxes are reported in 1×10^9 g POC. The pan-Arctic fluxes were estimated by scaling up from the watershed areas of the six rivers to the pan-Arctic drainage basin area (Figure 1), assuming equivalent areal POC yields and 67% areal coverage. The petrogenic endmember is assumed to only occur in the Mackenzie watershed and is therefore excluded from the upscaling. The percent total flux column shows the percent of the pan-Arctic seasonal or annual flux represented by each source.

		Ob'	Yenisey	Lena	Kolyma	Yukon	Mackenzie	Sum	Pan-Arctic	% total flux
Total POC flux	Spring	254 ± 11	130 ± 8	446 ± 35	101 ± 25	203 ± 10	480 ± 42	1494 ± 104	2230	100
	Summer	286 ± 22	68 ± 3	420 ± 44	55 ± 10	342 ± 20	154 ± 12	1285 ± 63	1918	100
	Winter	76 ± 7	29 ± 0	9 ± 1	2 ± 0	30 ± 2	22 ± 2	163 ± 7	243	100
	Annual total	615 ± 33	227 ± 11	875 ± 56	158 ± 34	575 ± 25	656 ± 54	2942 ± 150	4391	100
Shallow soil	Spring	8 ± 0	4 ± 0	31 ± 2	5 ± 1	53 ± 2	10 ± 1	108 ± 3	161	7
	Summer	3 ± 0	1 ± 0	8 ± 1	2 ± 0	103 ± 6	2 ± 0	117 ± 6	175	9
	Winter	2 ± 0	1 ± 0	0 ± 0	0 ± 0	2 ± 0	0 ± 0	5 ± 0	7	3
	Annual total	12 ± 1	5 ± 0	40 ± 3	7 ± 2	158 ± 7	11 ± 1	230 ± 9	343	8
Deep soil	Spring	30 ± 1	99 ± 6	22 ± 2	3 ± 1	41 ± 2	10 ± 1	202 ± 7	301	13
	Summer	23 ± 2	31 ± 1	4 ± 0	1 ± 0	51 ± 3	2 ± 0	111 ± 3	166	9
	Winter	15 ± 1	25 ± 0	0 ± 0	0 ± 0	5 ± 0	0 ± 0	45 ± 1	67	28
	Annual total	68 ± 4	154 ± 8	27 ± 2	4 ± 1	96 ± 0	11 ± 1	358 ± 10	534	12
Fresh terrestrial production	Spring	0 ± 0	0 ± 0	4 ± 0	1 ± 0	6 ± 0	0 ± 0	12 ± 0	18	<1
	Summer	0 ± 0	0 ± 0	0 ± 0	0 ± 0	7 ± 0	0 ± 0	7 ± 0	10	<1
	Winter	0 ± 0	0 ± 0	0 ± 0	0 ± 0	1 ± 0	0 ± 0	1 ± 0	1	<1
	Annual total	0 ± 0	0 ± 0	5 ± 0	1 ± 0	14 ± 1	0 ± 0	19 ± 1	28	<1
Aquatic biomass	Spring	213 ± 10	26 ± 2	272 ± 21	54 ± 13	35 ± 2	159 ± 14	718 ± 45	1072	48
	Summer	254 ± 20	36 ± 2	286 ± 30	33 ± 6	27 ± 2	59 ± 4	680 ± 35	1015	53
	Winter	58 ± 5	3 ± 0	5 ± 0	1 ± 0	14 ± 1	10 ± 1	89 ± 5	133	55
	Annual total	526 ± 28	65 ± 3	563 ± 37	88 ± 18	75 ± 3	227 ± 19	1487 ± 66	2219	51
Yedoma	Spring	-	-	103 ± 8	37 ± 9	63 ± 3	-	203 ± 10	303	14
	Summer	-	-	118 ± 12	19 ± 4	147 ± 9	-	283 ± 19	422	22
	Winter	-	-	3 ± 0	1 ± 0	8 ± 0	-	12 ± 1	18	7
	Annual total	-	-	223 ± 15	57 ± 12	218 ± 10	-	498 ± 25	743	17
Petrogenic	Spring	-	-	-	-	-	293 ± 26	-	-	13
	Summer	-	-	-	-	-	91 ± 7	-	-	5
	Winter	-	-	-	-	-	12 ± 1	-	-	5
	Annual total	-	-	-	-	-	395 ± 33	-	-	9



Figure 1. Map of the six rivers in the Arctic Great Rivers Observatory underlain with the extent and degradation state of permafrost (darker blue indicates more continuous permafrost, lighter blue indicates more discontinuous and sporadic permafrost; (8), yedoma deposits (20), and approximate petrogenic carbon source in the Mackenzie (e.g. 21).

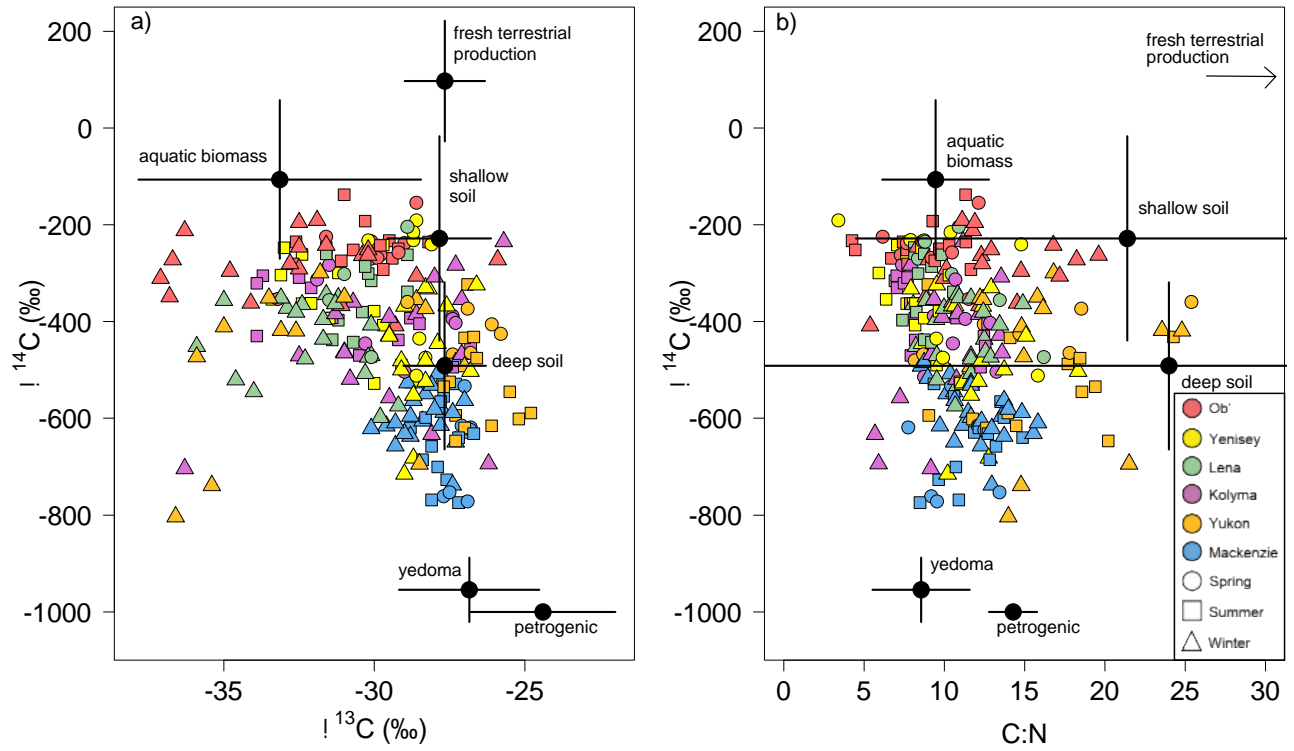


Figure 2. All samples from all rivers in a) $\Delta^{14}\text{C}$ versus $\delta^{13}\text{C}$ space and b) $\Delta^{14}\text{C}$ versus C:N space, with all endmembers and standard deviation ranges for each endmember shown. No single river uses all six endmembers; these are shown for an overview of data only.

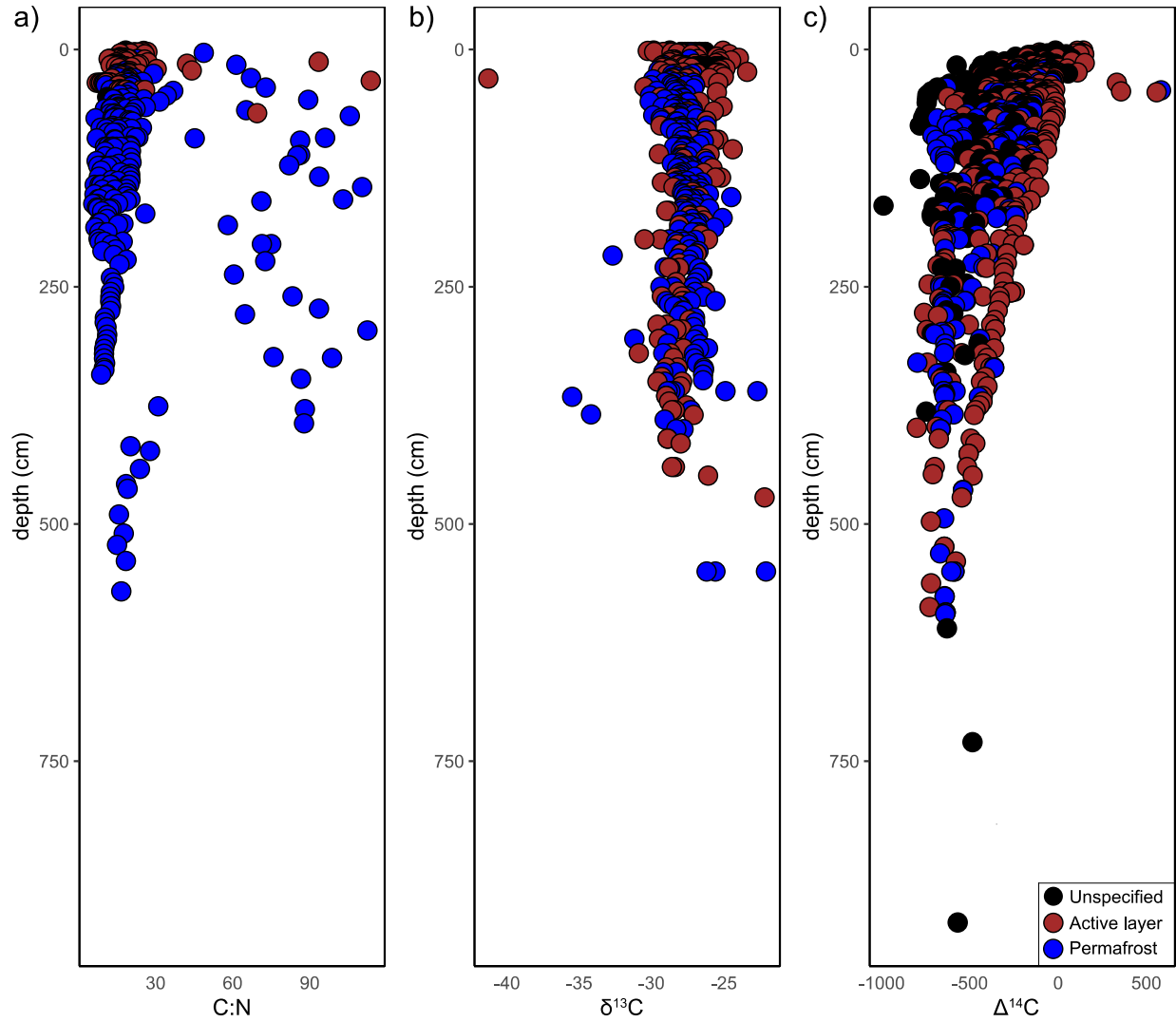


Figure 3. Samples from literature review used for soil (deep and shallow) endmembers. a) C:N, b) $\delta^{13}\text{C}$ values, and c) $\Delta^{14}\text{C}$ values for soil organic carbon with depth.