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Supplement of

Carbon dynamics in boreal peatlands of the Yenisey region, western Siberia

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Supplement

Supplement S1: Peat types and Bog surface

Raised bogs have a slightly convex surface which can be covered by Pine-dwarf shrubs-Sphagnum vegetation ('ryam' bog) (bogs) with homogenous hummocky surface or extensive mire complexes with ridge-hollow patterns. On the gentle slopes (gradient 0.003 – 0.008 m km⁻¹) vast ridge-hollow complexes exist, on the central flat part of large mire systems numerous shallow pools and small lakes develop. The vegetation comprises typical raised bog plant communities, where stunted (0.5 – 4 m high) pines (*Pinus sylvestris*) form more or less close tree layer or the trees are sparsely distributed on hummocks and ridges. (A subtype of the raised bog type is the "ryam" bog, which is specific and unique for Siberia. It is characterized by a tree layer of *Pinus* and dwarf shrubs with a *Sphagnum* and Monocot ground layer). Ericaceous dwarf shrubs such as *Ledum palustre*, *Chamaedaphne calyculata*, *Andromeda polifolia* on ridges and in 'ryams' are abundant. *Eriophorum vaginatum* and *Carex limosa*, as well as a few other species (*Scheuchzeria palustris*, *Rhynchospora alba*, *Oxycoccus* ssp., *Drosera* spp.) occur in waterlogged hollows. The ground layer is dominated by *Sphagnum* species, distributed following a moisture gradient with *Sphagnum fuscum* admixed with *S. angustifolium*, *S. magellanicum* on hummocks and *S. balticum*, *S. jensenii*, *S. majus*, *S. lindbergi*, *S. papillosum* in hollows (Lapshina and Vasiliev, 2001).

On sandy soils low stature *Pinus sylvestris* trees, dwarf shrubs and *Eriophorum vaginatum* are associated with the *Sphagnum angustifolium* vegetation establishes (with an admixture of *S. magellanicum* and *S. fuscum*). These communities presently form shallow *Sphagnum* peat deposits (0.5-1.5 m). Sometimes with a thin basal layer (0.1-0.2 m) of decomposed dense wood-cotton-grass or cotton-grass-sphagnum peat (Fig. 2, type I).

Most raised bogs contain only of a top layer of *Sphagnum fuscum* peat of 0.8 to 1.2 m thickness which developed on fens of sedges and herbaceous, rarely brown moss peat of 1.0 to 2.5 m thickness with a thin transitional *Scheuchzeria* or *Eriophorum* peat layer between. The fen peat types developed on *Equisetum fluviatile* peat, and on gyttia of 0.6 to 0.8 m depth indicating a lake environment at the start of the peat formation (Fig. 2, type II b). Outside of lake depression the same peat deposits may develop on waterlogged mineral soils (Fig. 2, type II a).

Fens are represented by three main types of peatlands: (1) sedge-*Scheuchzeria* mires developing in close water-encroached depressions on sandy soils, (2) herb-*Sphagnum* floating mires receiving run-off water or nutrient poor ground water (pure fens), and (3) Sedges and aapa mires developing under (waterlogged but) more nutrient rich conditions.

Type 1 fens consist of *Scheuchzeria* mires growing in depressions of the sandy uplands. Even though this type occupies only small areas of the contemporary peatland, this type is well presented in peat deposits both as initial stages of peat accumulation on sandy soils (Fig 2, type III a, core 25), which can be quite long, or as short transitional phase between nutrient rich fen and rain-fed bog layers in mixed peat deposits (Fig. 2, type II a, b, cores 14, 15).

Type 2 fens consist of herb-*Sphagnum* mires, which are usually connected to upper parts of small river valleys or creeks. They occur also between raised bogs and nutrient rich sedge-moss fens. They are characterized by *Menyanthes trifoliata*, *Carex* ssp. and *Sphagnum obtusum*. These mire types represent relative short-lived stages in peat and land surface development.

Most common fen types are homogenous sedge and sedge-moss open (tree less) fens or with sparsely distributed small birch trees fed both by run-off and lateral flow of ground water. Aapa mires are characterized by patterned surface with narrow peat ridges (strings) oriented perpendicular to the direction of surface water flow. Sedges, such as *Carex lasiocarpa*, *C. diandra*, *C. chordorrhiza*, and the herbaceous *Menyanthes trifoliata* form the herb layer. Usually some brown moss species (*Drepanocladus* spp., *Calliergon* spp, *Helodium blandowii*) and some *Sphagnum* species (*Sphagnum warnstorffii*, *S. subsecundum*) are present. This vegetation delivers a sedge, sedge-herb, or brown moss-sedge peat, which are very widespread as 1.2 to 2.2 m deep fen deposits (Fig. 2, type III b, c, cores 5, 11, 17). The peat profiles consist often of 10-20-cm *Sphagnum warnstorffii* peat on the top (Fig. 2, core 5). In the deepest parts of the peatland 0.6-0.8 m horsetail peat (and gyttja) was formed beneath the sedge-fen deposit (Fig. 2, type III b, core 11). In one case 0.4 m basal layer of wood peat was found under sedge-fen deposit (Fig. 2, core 17).

Forested swamps consist of the mire types fed by ground water. These mire types are characterized by tall well developed tree layer (about 8-18 m high). The mire types occur within the river valleys and on the periphery of the main peatland covering the young terraces of Yenisey River. The vegetation is characterized with mixed forest of *Pinus sibirica*, *Picea obovata*, *Betula pubescens* and tussock sedges of *Carex cespitosa*, *C. juncella*, *C. appropinquata* in association with numerous herbs, graminoids and moss species.

Within the wide meander of river valleys forested swamps develop (without trees as *Carex* herb fens. They are distinct by) on deep (5-6 m) peat deposits combined by 0.8-1.0 m wood peat on top of less decomposed herbaceous (fern, *Menyanthes*) and *Carex* peat (Fig. 2, type IV, core 28). The forested mire occurred on the periphery of the main peatlands developed on the shallow 0.5-1 m very well decomposed dense wood and sedge-wood peat deposits (Fig. 2, type V, core 19).

The profiles and the peat stratigraphy of the main peat types are described in **Table S1**.

Table S1: Present day peatland types in relation to peat profiles. The peat-type layers are listed from top to bottom. Bold letters indicate the peat layers of more than 1 m thickness; brackets indicate peat layers less than 30 cm. Bold numbers mark cores presented in Fig. 2. Peat profile types (4th column) contain (I) Shallow *Sphagnum* peat deposits representing mainly modern peat formation of raised bogs on sandy soils. (II) Mixed peat deposits in centers of well-developed raised bogs composed of 1-2 m deep fen peat covered by 0.5-1 m sphagnum raised bog peat layer. (III) Sedge-fen type peat deposits of *Carex* associated with through-flow of mineral-rich water from run-off or ground water including the initial transformation to rain-fed *Sphagnum* bogs. (IV) Deep herbaceous & herb-sedge peat deposits sometimes covered at the later stage by woody peat in old river valleys. (V) Shallow woody peat deposits developed by forested swamps on the loamy soils which are widespread on the young left terrace of Yenisey River. The description of peat profile types contains also information on horizon depth.

Peatland type	Area, km ²	Area %	Peat profile type	Depth, m	Stratigraphy of Peat types	Number of peat cores**
A. Raised bogs & ridge-hollow complexes	2256.6	81	I. Shallow sphagnum deposit	0.5-1.5	<i>Sphagnum</i> ; <i>Sphagnum-Eriophorum</i>	1, 3, 3a, 23
			II. Mixed peat deposit a) on mineral soils	3-4	<i>Sphagnum-Menyanthes-Wood</i>	7, 15

			b) on gyttia		<i>Sphagnum-Scheuchzeria-Hypnum</i> -(gyttija); <i>Sphagnum-Scheuchzeria-Carex-Hypnum-Equisetum</i> -gyttia;	6, 10, 12, 13, 14 ;
B. Fens & aapa mires	368.4	13	III. Sedge-fen type a) transitional stage to rain-fed bog;	1.0-1.5	<i>Carex-Scheuchzeria</i> ; <i>Sphagnum-Scheuchzeria</i> ; <i>Sphagnum-Carex-Mentyanthes</i> ; <i>Scheuchzeria-Carex-Mentyanthes</i> ; <i>Scheuchzeria-Carex</i> ;	1a, 2, 4, 9, 18, 25
			Fen stage b) on mineral soils	1.2-2.7	(<i>Sphagnum</i>)- <i>Scheuchzeria</i> (<i>Sphagnum</i>)- <i>Carex</i> ; <i>Hypnum-Carex-Wood</i> ; (<i>Scheuchzeria</i>)- <i>Carex-Mentyanthes</i> ; Carex ; (<i>Hypnum</i>)- <i>Scheuchzeria-Carex</i> .	5, 17, 21, 22, 26
			c) on gyttia		<i>Carex-Mentyanthes-Equisetum</i> -gyttja;	11
C. Forested swamps & wooded fens	182.4	7	IV. Deep herb-sedge-woody deposits	5.0-5.8	Wood- Carex-Mentyanthes ;	28, 29
			V. Shallow woody deposits	0.5-1.5	Sedge-wood; Wood	19, 20

Supplement S2: Carbon concentrations

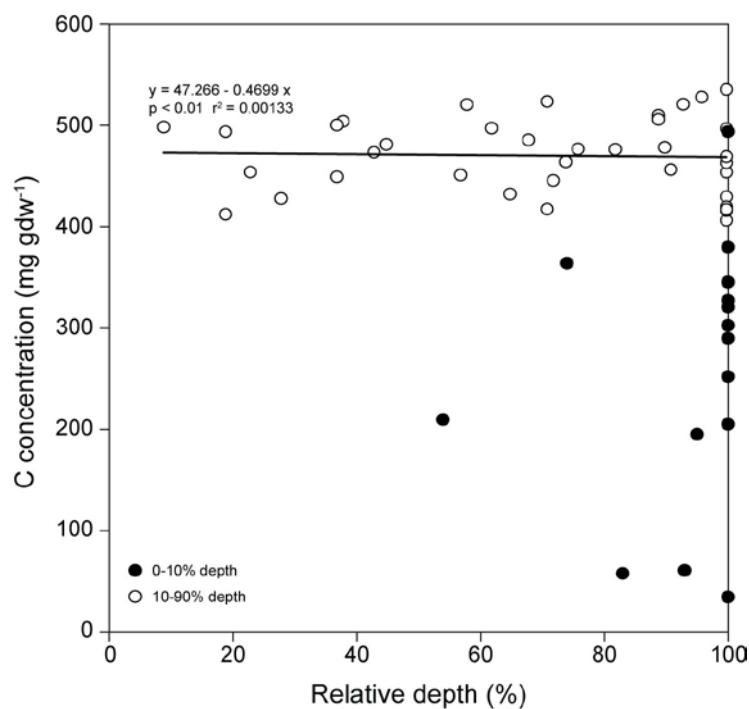


Fig. S2: Carbon concentrations as related to the relative bog depth. 100% represents the total length of the core. Filled circles: 0 to 10% of total core length, un-filled circles: 10 to 90% of the total core length

Supplement S3

Results of AMS 14C analysis

Asterisk * indicates data where a mix-up of samples occurred or age sequence was inverted

Core	Depth (cm)	Lab. code	POM				DOC			Stage of peatland type	Dated peat type
			14C years BP	Std deviation	Calibrate d 14C age (yr BP) POM	Std deviation POM	Lab. code	Calibrate d 14C age (yr BP) DOC	Std deviation DOC		
1a	102-103	3613	4290	23	4852	10	3614	4036	49	Fen (transitional)	Carex
3	84-85	3625	495	20	525	9	3626	510	9	Raised bog	Sphnum
3a	76-77	3619	2255	20	2260	76	3620	1485	62	Raised bog	Eriophorum
4	114-115	3609	3595	22	3910	48	3610	2610	107	Fen	Menyanthes
4	119-120	3611	3840	22	4225	65	3612	3765	60	Fen	Menyanthes
5	49-50	3593	400	17	485	15	3694	145	150	Fen	Carex
5	99-100	3607	3300	23	3525	40	3608	1980	53	Fen	Carex
5	134-135	3595	5655	25	6440	30	3596	5625	25	Fen	Carex
6	280-281	3621	9150	30	10310	65	3622	7895	40	Shallow water	Equisetum
7	130-133	3623	5060	25	5820	71	3624	3860	25	Fen	Carex
8	195-196	3617	8310	27	9345	60	3618	7220	40	Fen	Menyanthes
9	200-201	3615	8515	30	9520	17	3616	7885	45	Fen	Menyanthes
10	295-296	3508	10935	44	12885	25	3509	8885	105	Lake	Gytia
11	47-49	3556	540	29	535	13	3557	620	50	Fen	Carex
11	97-98	3562	3287	22	3515	40	3563	2415	50	Fen	Menyanthes
11	147-148	3560	7032	29	7885	44	3561	7050*	102	Fen	Carex
11	197-198	3554	8395	32	9445	35	3555	6085	90	Fen	Menyanthes
11	247-248	3558	10615	33	12715	55	3559	5965*	27	Shallow water	Equisetum
11	277-278	3564	11430	33	13285	37	3565	6710	34	Lake	Gytia
12	227-228	3506	9183	45	10325	75	3507	8280	70	Shallow water	Equisetum
13	40-50	3575	250	18	295	10	3576	1950	0	Raised bog	Sphnum
13	97-98	3569	485	17	520	10	3570	1950	0	Raised bog	Sphnum
13	147-148	3577	2723	22	2815	30	3578	2610	115	Fen	Scheuchzeria
13	197-198	3587	6113	27	7045	102	3588	5125	150	Fen	Carex
13	247-248	3567	7455	25	8275	62	3568	4740	87	Fen	Hypnum
13	297-298	3571	8103	25	9040	40	3572	3767	118	Fen	Hypnum
13	347-347	3573	8568	30	9538	10	3574	8390	24	Fen	Hypnum
14	398-399	3110**	12953	52	15286	140	3046*	11280	35	Lake	Gytia
15	49-50	3585	290	20	363	62	3586	705	22	Raised bog	Sphnum
15	99-100	3579	640	20	610		3580	1338		Raised bog	Sphnum
15	145-146	3583	865	23	2230	75	3584	1360	21	Fen	Menyanthes
15	166-167*	3516	2196	23	765*	25	3517	855*	55	Fen	Menyanthes
15	199-200	3581	6865	30	7695	30	3582	5380	70	Fen	Menyanthes
15	224-225	3589	8385	30	9403	70	3590	7065	92	Forested swamp	Carex-woody
17	47-48	3601	160	18	142	133	3602	392	73	Fen	Hypnum
17	97-98	3597	1263	20	1218	39	3598	1950	0	Fen	Carex
17	147-148	3591	4155	22	4725	95	3592	2264	83	Fen	Carex
17	197-198	3599	7080	27	7912	41	3600	4695	115	Fen	Carex
17	247-248	3603	8830	29	9947	170	3604	6266	46	Forested swamp	Woody
17	262-263	3605	8935	30	10070	120	3606	6264	46	Forested swamp	Woody
18	194-195	3550	7910	30	8705	70	3551	6295	13	Fen	Carex
19	88-89	3366	3182	19	3412	31	3367	3595	31	Forested swamp	Woody
20	39-40	3552	1263	20	1218	39	3553	950	23	Forested swamp	Woody
21	146-147	3356	7900	24	8693	58	3358	8118	64	Fen	Menyanthes
22	40-50	3512	1245	25	1205	55	3513	1114	54	Fen	Carex
22	99-100	3514	3990	30	4470	45	3515	4355	60	Fen	Carex
22	115-116	3510	5655	35	6440	35	3511	5540	55	Fen	Carex
23	99-100	3362	3300	20	3521	38	3363	2615	100	Pine bog	Eriophorum-woody
25	159-160	3364	5990	20	6835	46	3365	5530	55	Fen (transitional)	Scheuchzeria
26	49-50	3371	855	16	755	18	3372	1950	0	Fen (transitional)	Scheuchzeria
26	99-100	3368	3570	19	3866	24	3369	3415	26	Fen	Carex
26	149-150	3504	6115	33	7046	107	3505	5380	68	Fen	Menyanthes
26	199-200	3370	7975	33	8879	101				Fen	Carex
26	220-221	3373	8110	25	9044	36	3374	7345	70	Fen	Carex
27	145-146	3360	7620	25	8410	15	3361	7551	31	Fen	Menyanthes-Carex
28	562-563	3518	10180	40	11876	104	3519	9513	22	Fen	Menyanthes
28	587-588	3520	10450	44	12421	181	3521	9177	82	Fen	Menyanthes
29	47-48	3546	2185	25	2226	78	3547	1950	0	Fen	Menyanthes-Carex
29	97-98	3542	3365	25	3605	35	3543	2260	78	Fen	Menyanthes-Carex
29	147-148*	3534	7360	66	8175*	125	3535	2798	44	Fen	Menyanthes-Carex
29	197-198	3526	6080	34	6941	47	3527	5701	40	Fen	Menyanthes-Carex
29	247-248	3528	7162	37	7985	25	3529	5161	118	Fen	Menyanthes-Carex
29	297-298	3548	8085	30	9033	38	3549	5567	76	Fen	Menyanthes-Carex
29	347-348	3544	8815	35	9925	185	3545	12545	140	Fen	Menyanthes-Carex
29	397-398	3524	9345	40	10580	70	3525	7380	50	Fen	Menyanthes-Carex
29	447-448	3532	9915	40	11296	48	3533	5675	50	Fen	Menyanthes-Carex
29	497-498	3522	10230	40	11950	120	3523	8880	105	Fen	Menyanthes-Carex
29	539-540*	3530	6900	35	7720	40	3531	6267	40	Fen	Menyanthes-Carex