



Supplement of

Field-scale CH₄ emission at a subarctic mire with heterogeneous permafrost thaw status

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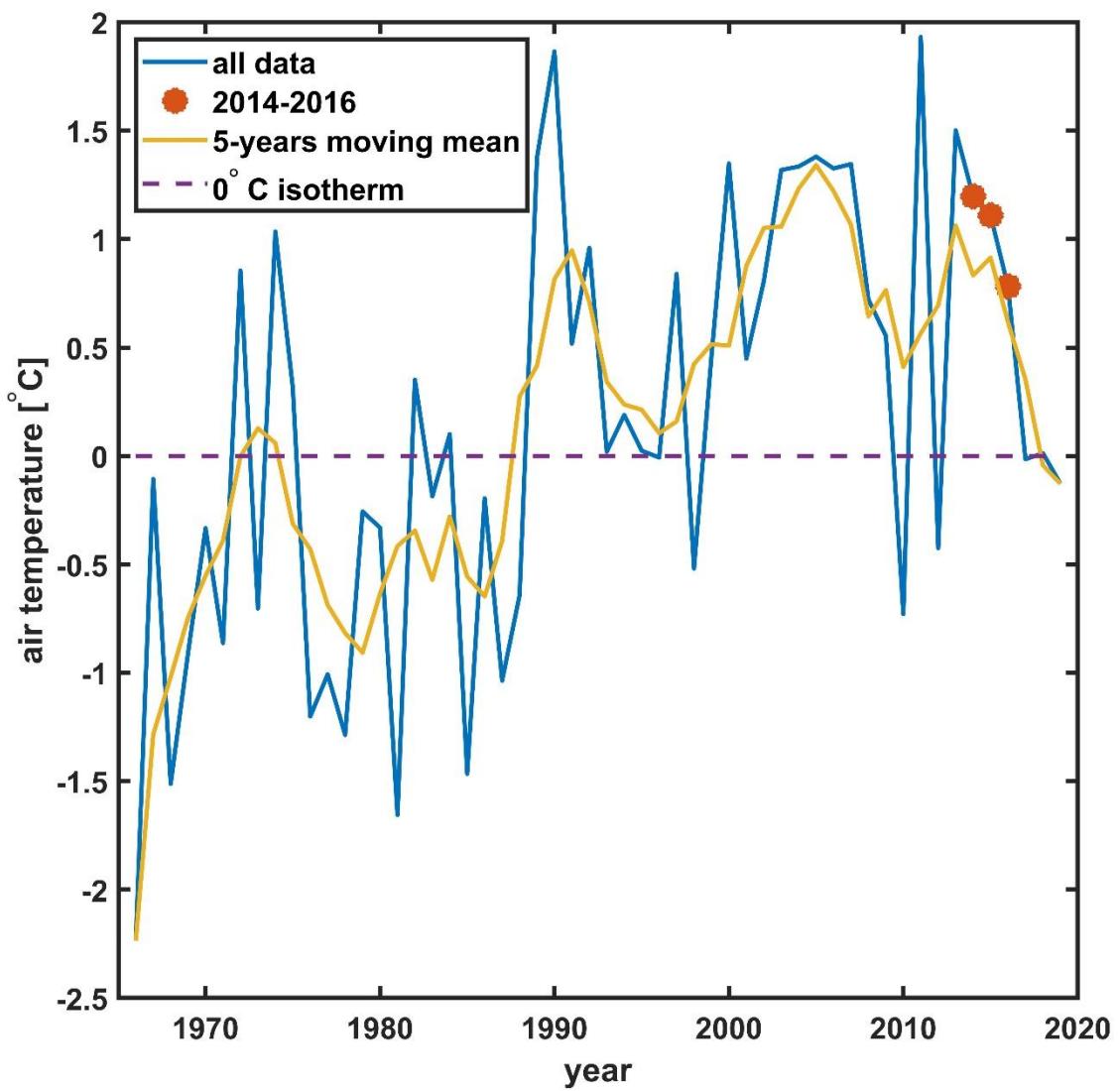


Figure S1. Time series of near-surface air temperature measurements recorded at the SMHI (Sveriges meteorologiska och hydrologiska institut) station at ANS (Abisko Naturvetenskapliga Station) at 1.5 m a.g.l., 10 km east of Stordalen Mire; orange circles indicating the years 2014-2016.

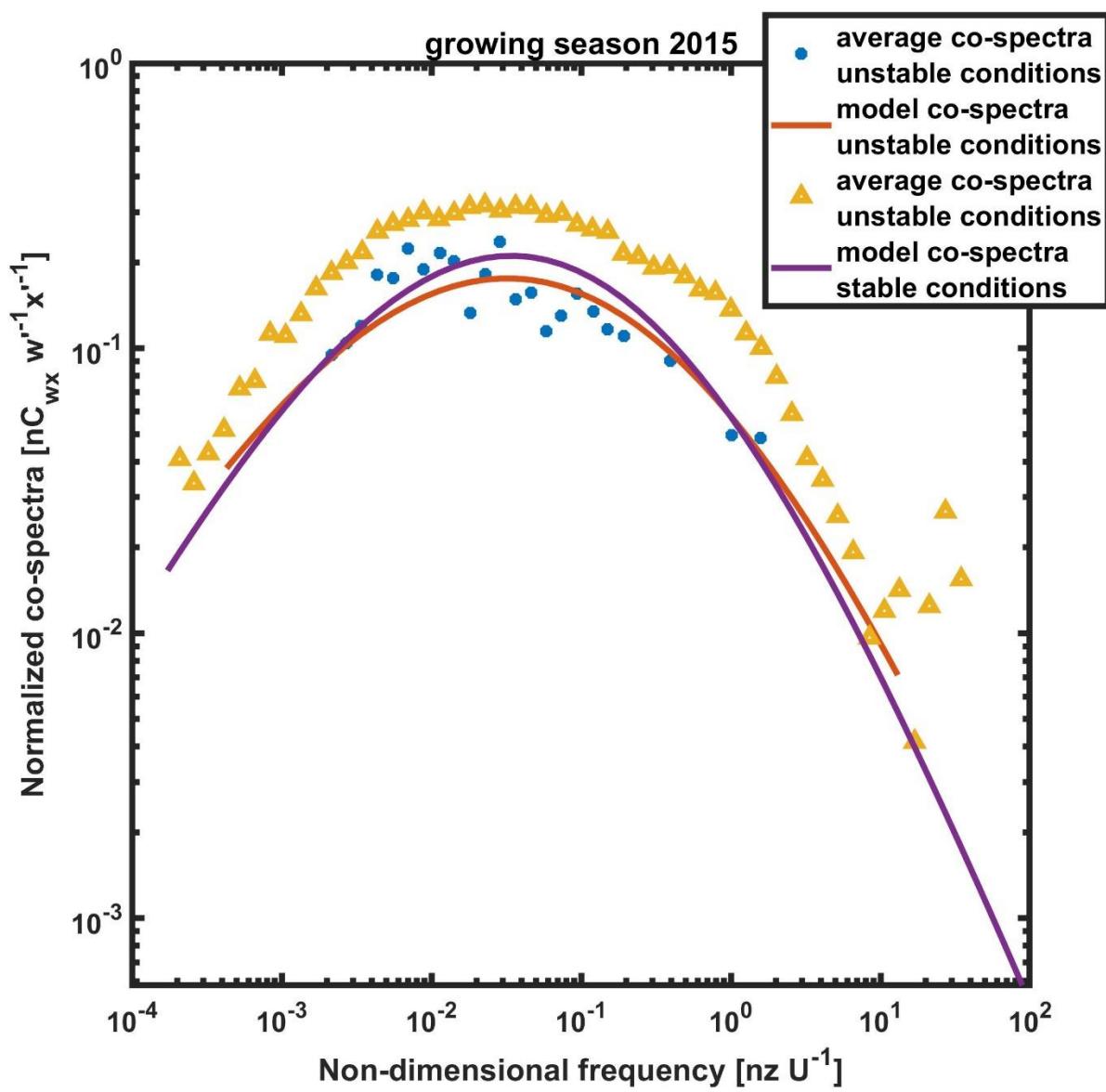
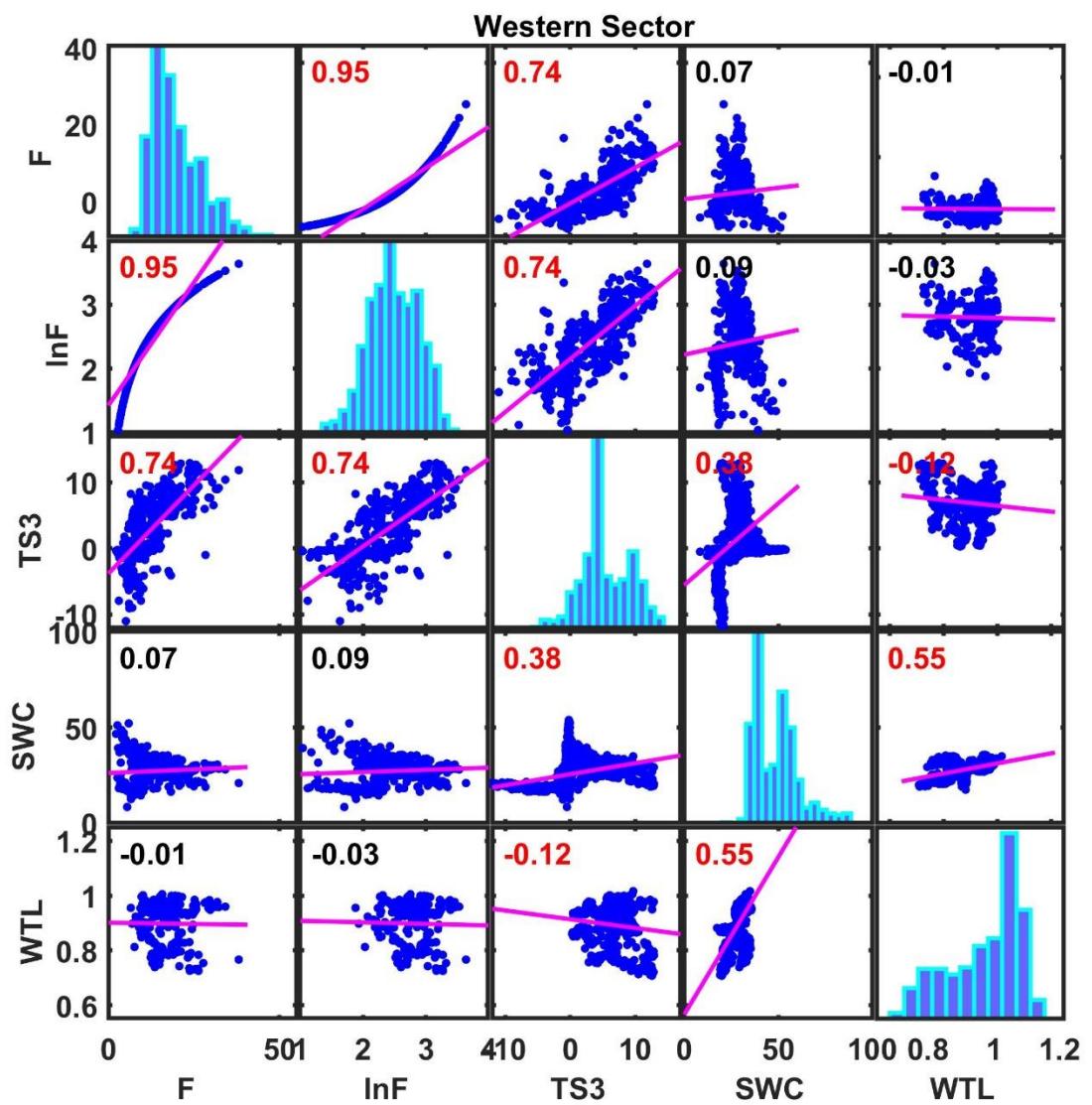


Figure S2. Example of the averaged and modelled co-spectra for stable and unstable conditions during the growing season in 2015.



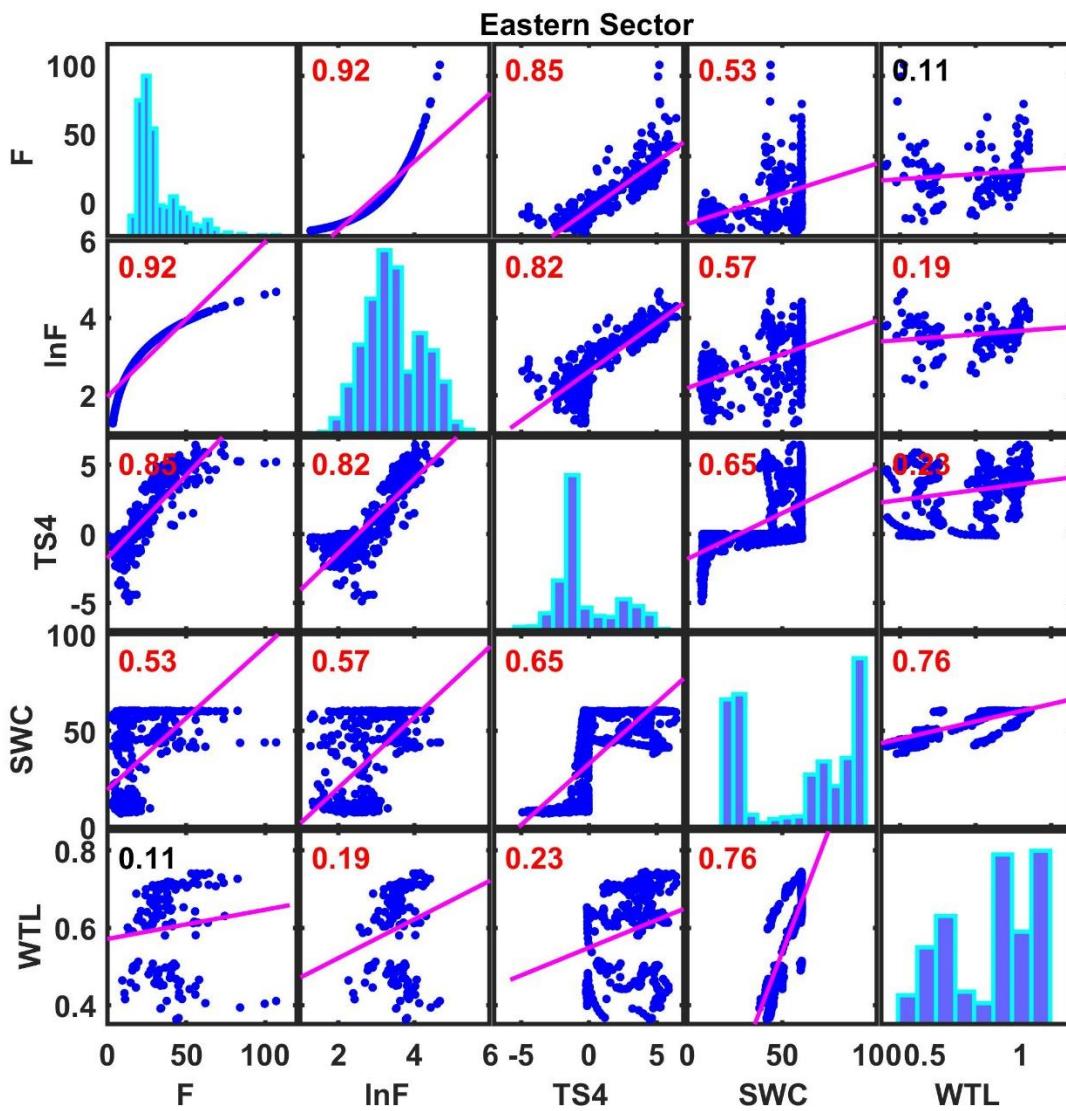


Figure S3. Correlation matrix for daily averages of methane fluxes (F), its logarithm (lnF), and chosen environmental variables (peat temperature at 10 cm (TS3), 30 cm (TS4), soil water content (SWC), and water table level (WTL)) for the western sector (top panel) and eastern sector (bottom panel) for the years 2014-2016. The number in the top corner of each subplot is R^2 . The red color for this number shows a significant correlation. R^2 displayed in black indicates that the correlation is not significant.

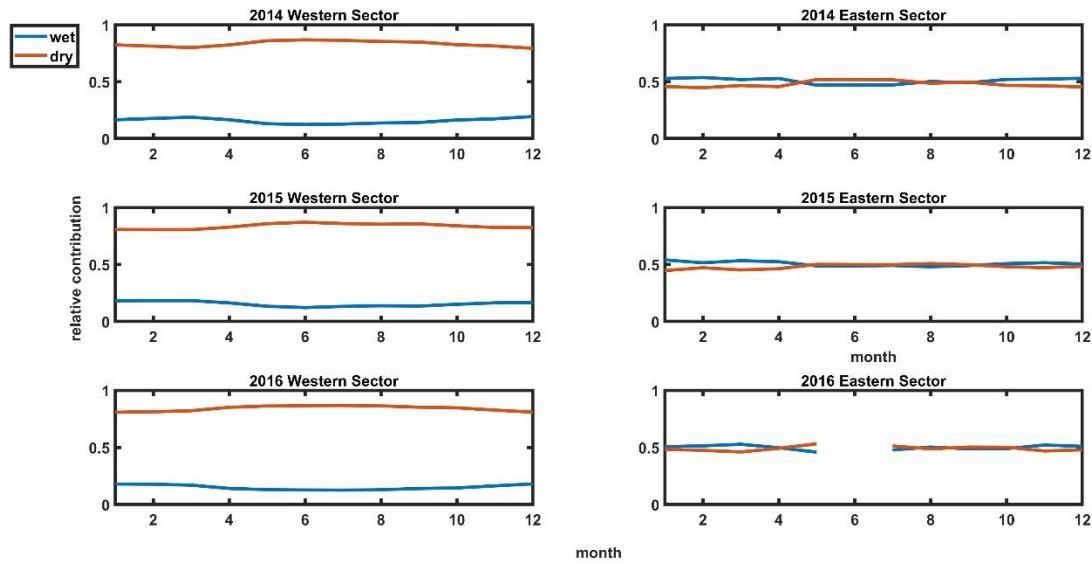


Figure S4. Monthly mean of the relative contribution of the different surface cover classes to the tower flux footprint

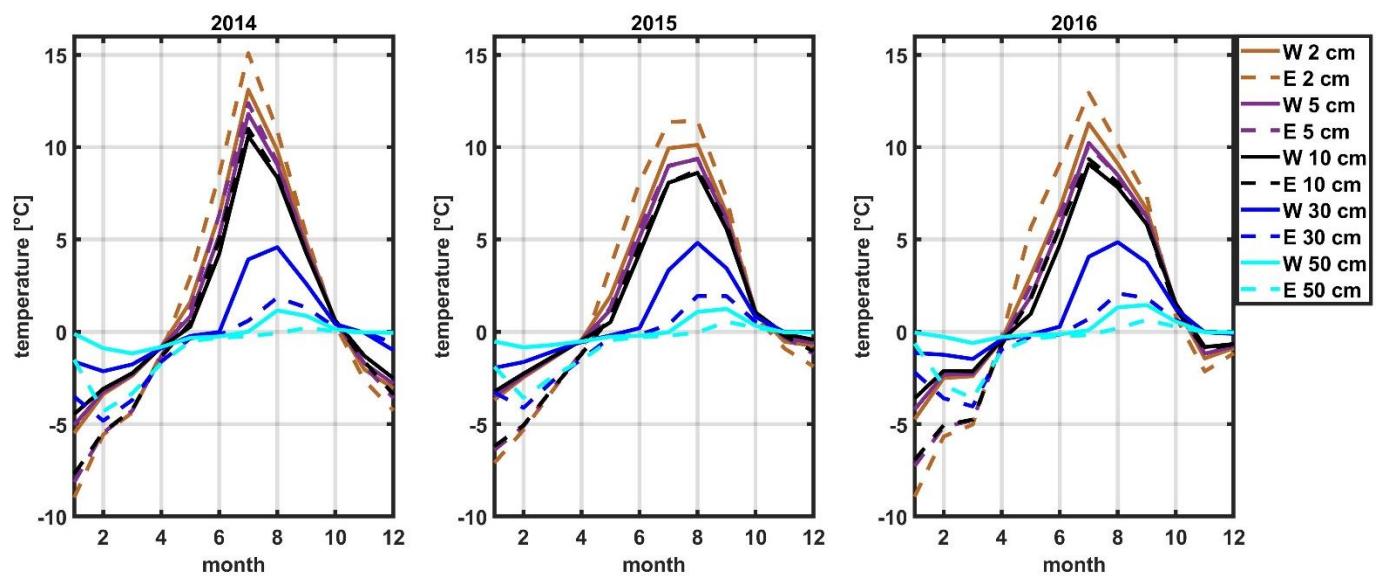
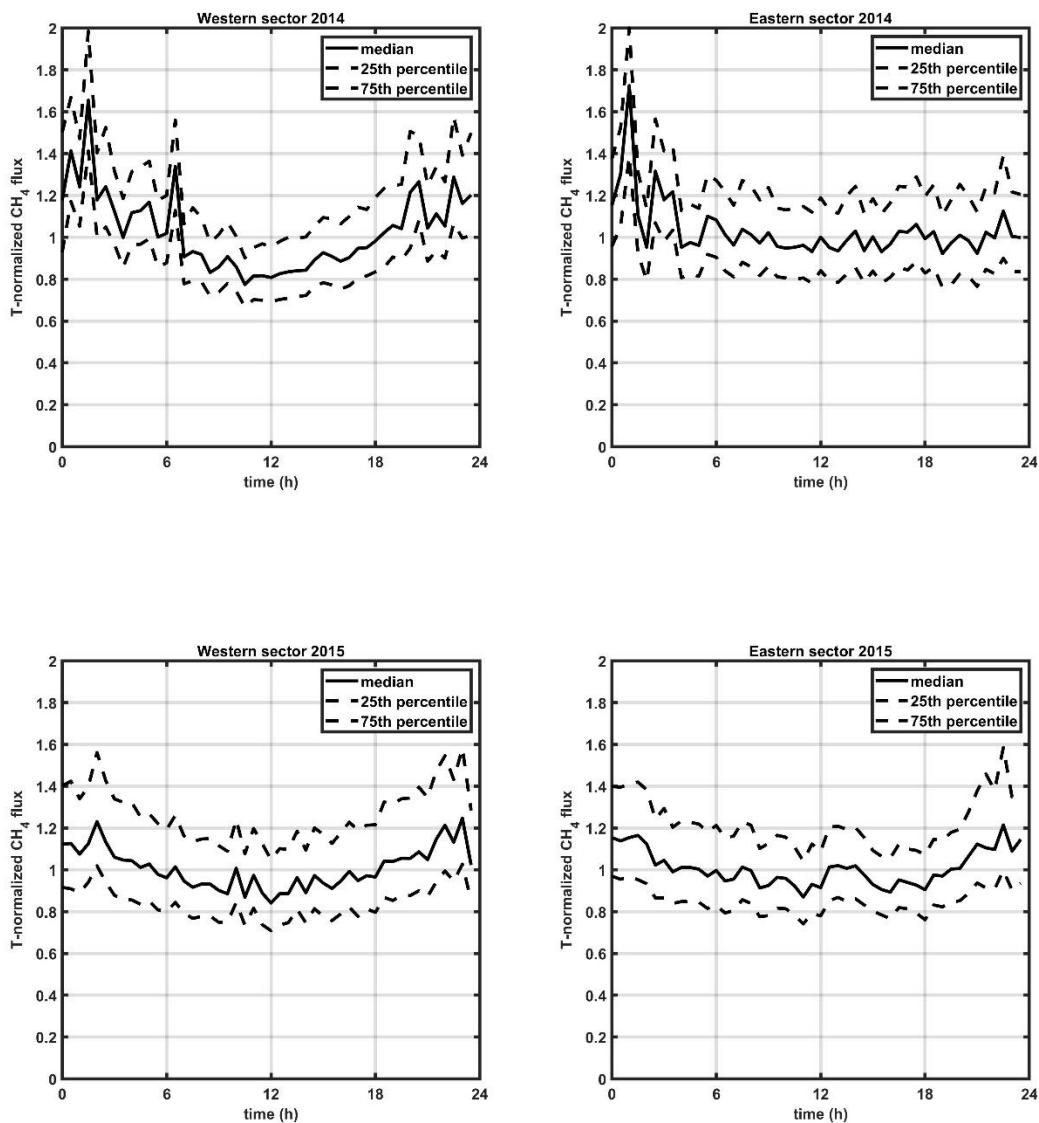


Figure S5. Monthly average of peat temperature for each layer for the western and eastern sector for the years 2014-2016.



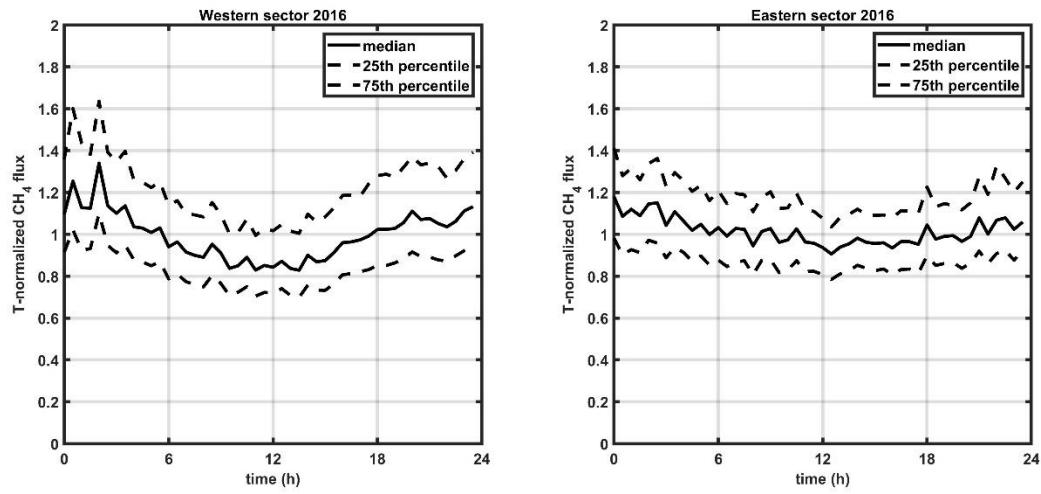
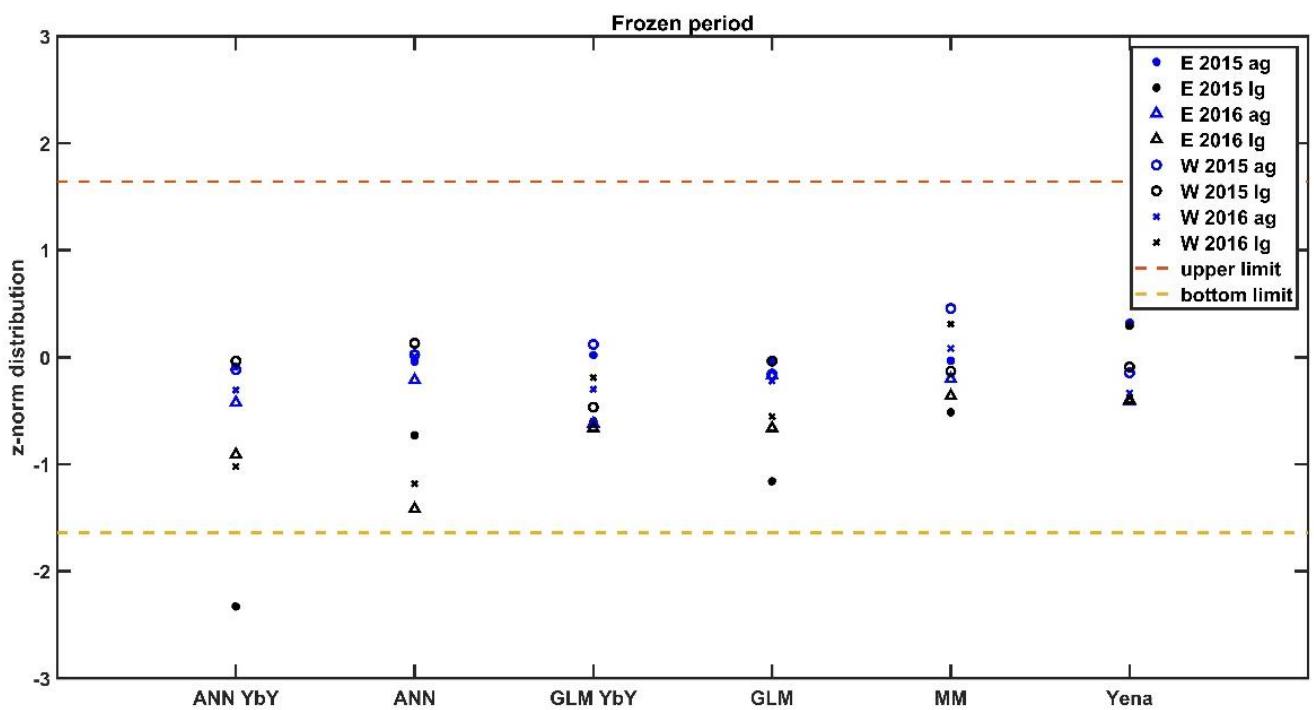
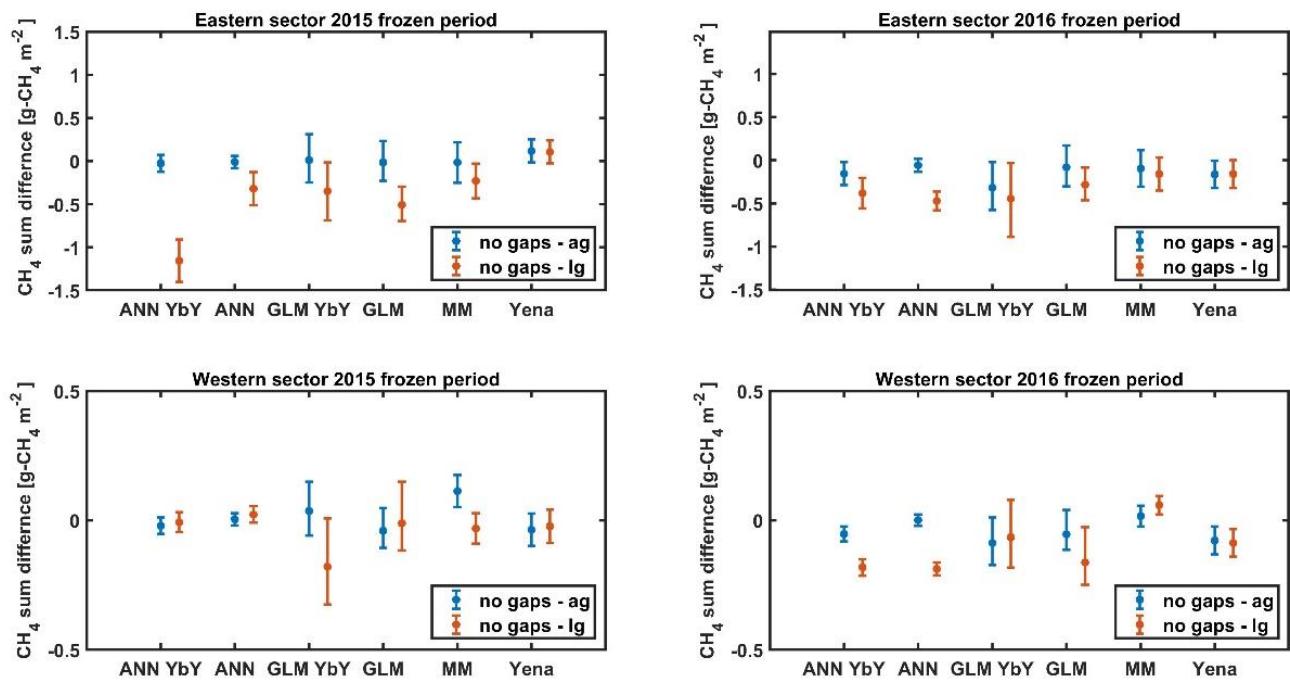
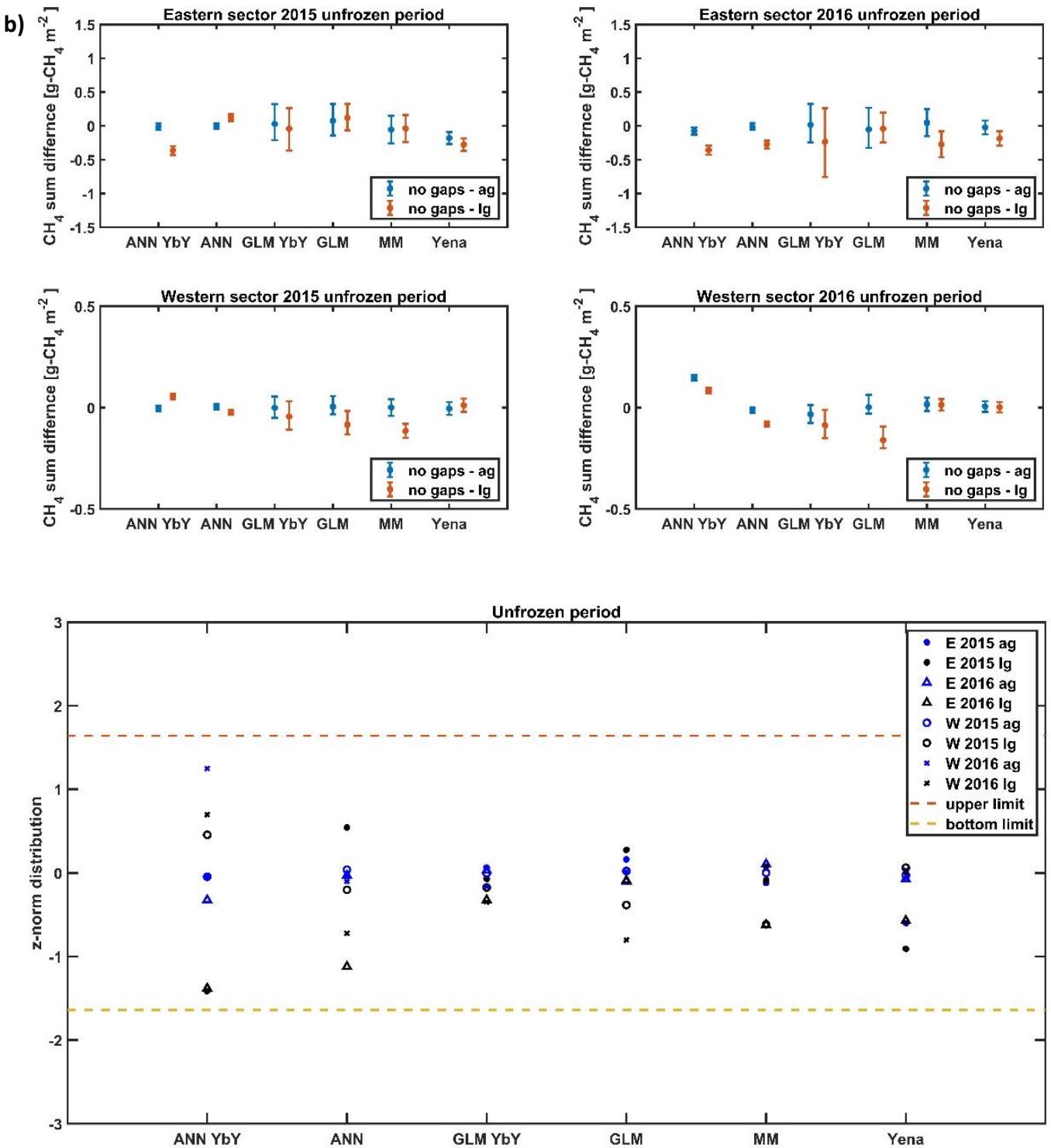


Figure S6. The diel cycle of CH₄ fluxes for the western and eastern sector for the unfrozen period for the years 2014-2016.

a)





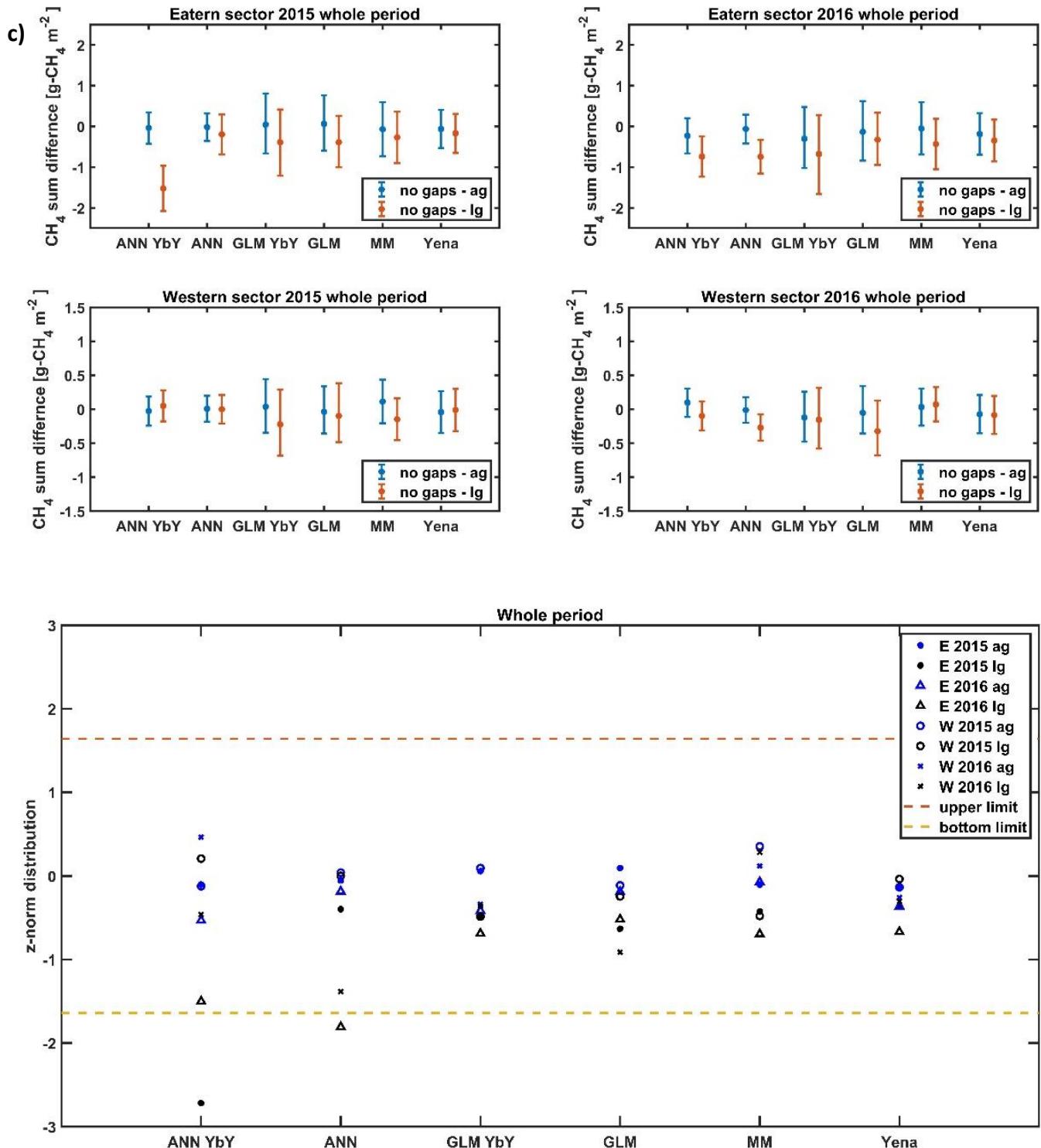


Figure S7. Differences for a) frozen b) unfrozen and c) whole period between the estimation of annual sums of CH₄ fluxes for models with and without artificial gaps with the length of 35-days and 80-days (Panels 1-4). Panel 5 shows a test if these differences are significant. ANN - the artificial neural network for all years, ANN YbY - artificial neural network each year separately, Jena - Jena online gap-filling tool, MM - moving mean with 5-day moving window, GLM- the general linear model for all years, GLM YbY - the general linear model for each year separately. The shaded light blue area is frozen period (see Section 2.8). Ag- gaps of 35-days length and Lg – gaps of 80-days length.

Table S1. Ancillary measurements at the ICOS Sweden station Abisko-Stordalen.

Measured variable	Measurement height	Sensor type	Parameters type
	(m a.g.l.)		
peat temperature at 5 levels	-0.02, -0.05, -0.10, -0.30, -0.50	Campbell Thermocouple, Type E (chromel-constantan)	
soil heat flux	-0.05	Hukseflux HFP01SC	below ground
volumetric soil water content	0.00 to -0.06	Delta-T ML2x, vertical	
ground water level	0	Campbell CS450	
incoming shortwave radiation, pyranometer	4.71	Kipp&Zonen CMP21	
net shortwave radiation, net radiometer	3.82	Kipp&Zonen CNR4	
net longwave radiation, net radiometer	3.82	Kipp&Zonen CNR4	
net radiation, net radiometer	3.82	Kipp&Zonen CNR4	
incoming shortwave radiation, net radiometer	3.83	Kipp&Zonen CNR4	
outgoing shortwave radiation, net radiometer	3.8	Kipp&Zonen CNR4	
incoming long-wave radiation, net radiometer	3.83	Kipp&Zonen CNR4	
outgoing long-wave radiation, net radiometer	3.8	Kipp&Zonen CNR4	above ground
air pressure	1.65	Vaisala PTB210	
incoming photosynthetic active radiation, quantum sensor	3.92	Apogee SQ-110	
outgoing photosynthetic active radiation, quantum sensor	3.82	Apogee SQ-110	
incoming photosynthetic active radiation, sunshine sensor	4.68	Delta-T BF5	
diffuse incoming photosynthetic active radiation, sunshine sensor	4.68	Delta-T BF5	
sunshine duration, sunshine sensor	4.68	Delta-T BF5	

target surface temperature	3.88	Apogee SI-111
air temperature	2.5	Rotronic MP102H
relative humidity	2.5	Rotronic MP102H
precipitation	1.83	Geonor T200BM
snow depth	1.5	Campbell Scientific SR50 ATH

Table S2. Summary of GLM selected parameters. Peat temperature, SWC: soil water content, Rn: net radiation, SW_in: shortwave incoming radiation, VPD: vapor pressure deficit, GPP: gross primary production, SE: standard error, tStat: t-statistic, pValue: p-value.

Eastern sector 2014				
Row	Estimate	SE	tStat	pValue
(Intercept)	-4.79687	0.05968	-80.37284	0.00000
PEAT				
TEMPERATURE	0.11525	0.01885	6.11419	0.00000
SWC	0.00689	0.00187	3.69087	0.00032
PEAT				
TEMPERATURE ²	0.02410	0.00384	6.28377	0.00000
Eastern sector 2015				
Row	Estimate	SE	tStat	pValue
(Intercept)	-4.84989	0.06301	-76.96779	0.00000
PEAT				
TEMPERATURE	0.14034	0.02082	6.74142	0.00000
SWC	0.00602	0.00153	3.93493	0.00012
Rn	0.01860	0.00567	3.27898	0.00127
SW_in	-0.00664	0.00059	-11.30990	0.00000
SWC/Rn	-0.00018	0.00009	-2.05366	0.04157
PEAT				
TEMPERATURE ²	0.01825	0.00443	4.12108	0.00006
Eastern sector 2016				
Row	Estimate	SE	tStat	pValue
(Intercept)	-4.4443	0.0850	-52.3046	0.0000
GPP	0.3464	0.0558	6.2090	0.0000
PEAT				
TEMPERATURE	0.1812	0.0224	8.0865	0.0000
SWC	-0.0220	0.0084	-2.6130	0.0098
SW_in	-0.0065	0.0005	-11.9590	0.0000
VPD	0.8146	0.2345	3.4734	0.0007
GPP/PEAT				
TEMPERATURE	-0.0414	0.0113	-3.6811	0.0003
SWC/ SW_in	0.0001	0.0000	5.4787	0.0000
SWC ²	0.0004	0.0001	3.1690	0.0018
Eastern sector 2014-2016				
Row	Estimate	SE	tStat	pValue
(Intercept)	-4.7637	0.0374	-127.3934	0.0000
GPP	0.3352	0.0477	7.0349	0.0000
PEAT				
TEMPERATURE	0.1489	0.0146	10.2026	0.0000
SWC	0.0050	0.0010	4.9221	0.0000
Rn	0.0006	0.0010	0.5656	0.5719
SW_in	-0.0052	0.0005	-10.5466	0.0000

VPD	-0.2456	0.3177	-0.7731	0.4399
GPP/PEAT				
TEMPERATURE	-0.0840	0.0116	-7.2297	0.0000
PEAT				
TEMPERATURE/				
SW_in	0.0004	0.0001	3.4080	0.0007
SWC/NetRad	0.0001	0.0000	4.0959	0.0000
PEAT				
TEMPERATURE ²	0.0249	0.0030	8.2302	0.0000
VPD ²	0.5832	0.2826	2.0640	0.0396

Western sector 2014

Row	Estimate	SE	tStat	pValue
(Intercept)	-4.35994	0.11600	-37.58597	0.00000
PEAT				
TEMPERATURE	0.06075	0.00472	12.86436	0.00000
SWC	-0.01839	0.00436	-4.21854	0.00006

Western sector 2015

Row	Estimate	SE	tStat	pValue
(Intercept)	-5.00736	0.03709	-134.98976	0.00000
GPP	0.16341	0.04013	4.07229	0.00007
PEAT				
TEMPERATURE	0.06886	0.01007	6.83508	0.00000
Rn	0.00309	0.00073	4.22764	0.00004
SW_in	-0.00436	0.00055	-7.96662	0.00000

Western sector 2016

Row	Estimate	SE	tStat	pValue
(Intercept)	-5.14195	0.05709	-90.06116	0.00000
GPP	0.57642	0.10960	5.25945	0.00000
PEAT				
TEMPERATURE	0.05311	0.01013	5.24318	0.00000
SW_in	-0.00495	0.00085	-5.84729	0.00000
GPP ²	-0.07372	0.02213	-3.33163	0.00106
SW_in ²	0.00001	0.00000	2.58708	0.01051

Western sector 2014-2016

Row	Estimate	SE	tStat	pValue
(Intercept)	-5.0698	0.0345	-146.9896	0.0000
GPP	0.4286	0.0692	6.1946	0.0000
PEAT				
TEMPERATURE	0.0589	0.0065	9.0416	0.0000
SW_in	-0.0031	0.0002	-14.9783	0.0000
PEAT				
TEMPERATURE/				
SW_in ²	0.0002	0.0000	5.5386	0.0000
GPP ²	-0.0777	0.0159	-4.8855	0.0000

Table S3. Summary of annual emissions as result of the different models as described in section 2.6

	Annual emission [gC m ⁻² a ⁻¹]	Range of emission [gC m ⁻² a ⁻¹]	Annual emission [gC m ⁻² a ⁻¹]	Range of emission [gC m ⁻² a ⁻¹]	Annual emission [gC m ⁻² a ⁻¹]	Range of emission [gC m ⁻² a ⁻¹]
	2014 E		2015 E		2016 E	
ANN YbY	5.5	[5.0, 5.9]	4.9	[4.8, 5.2]	6.1	[5.9, 6.3]
ANN GLM	5.1	[4.9, 5.3]	5.1	[4.9, 5.2]	6.1	[5.9, 6.3]
YbY GLM	5.5	[5.0, 6.0]	4.9	[4.5, 5.2]	6.0	[5.6, 6.5]
MM Jena	4.9	[4.6, 5.4]	5.2	[4.8, 5.5]	5.9	[5.5, 6.3]
MM Jena	5.8	[5.4, 6.2]	5.1	[4.7, 5.4]	6.1	[5.8, 6.4]
Jena	5.3	[5.0, 5.7]	5.0	[4.8, 5.2]	6.1	[5.8, 6.4]
	2014 W		2015 W		2016 W	
ANN YbY	4.0	[3.7, 4.3]	2.8	[2.8, 3.0]	3.1	[3.0, 3.2]
ANN GLM	2.9	[2.8, 3.0]	3.0	[2.9, 3.1]	3.1	[3.0, 3.2]
YbY GLM	3.4	[3.0, 3.7]	2.8	[2.6, 3.0]	2.8	[2.7, 3.1]
MM Jena	2.8	[2.6, 3.1]	2.8	[2.6, 3.0]	2.9	[2.8, 3.1]
MM Jena	3.7	[3.5, 4.0]	2.9	[2.7, 3.1]	3.1	[3.0, 3.3]
Jena	3.7	[3.3, 4.0]	2.8	[2.7, 3.0]	3.1	[3.0, 3.3]