ID: B41A-0284 Micro-habitat variability in CO_2 exchange and regulation in a Mountain Peatland, Fichtelgebirge Germany

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Introduction: Peatlands in the Northern Hemisphere play a significant role in CO_2 sequestration and storage but are also potential sources in the changing climate scenario. Intensive measurements were carried out to understand how ecosystem CO_2 exchange processes are regulated and how the respective herbaceous plant types, grass/ sedge and moss, contribute to the overall CO_2 exchange of a mountain peatland in Fichtelgebirge, south-eastern Germany.

Methods: Chambers (Droesler et al., 2005) were used to measure CO_2 exchange in two plant communities. Leaf level responses were examined with an infra red gas analyzer (IRGA, LI-6400). Parameter fits and comparisons for net ecosystem exchange (NEE) and gross primary production (GPP) among the different ecosystem components were conducted using an empirical hyperbolic light response model (Owen et al., 2007). Changes in biomass and leaf area index (LAI) of the vegetation were also continuously monitored during the active vegetative period in summer (Fig. 1 & 2).

Results: Combined peak biomass production for the grasses and sedges was 326 g dwt. m^{-2} while the peak biomass for mosses was 182 g dwt. m^{-2} Respectively (Fig. 2). Peak Gross Primary Production (GPP) of 30±0.8 µmol m^{-2} s^{-1} was observed in July (Fig. 3 & 4) in the combined sedge/ grass vegetation while it was half this rate in moss. Both sedges and grasses reacted to increases in VPD by closing their stomata (Fig. 5) and this occurred around midday when VPD values of 1.5 hPa were attained. Measurements of leaf water potentials (Ψ_L) showed that the plants suffered from water stress (Ψ_L = -2.0 MPa) during this period, even when the peat was waterlogged. These stomatal responses had direct influence on CO_2 assimilation, which saturated or declined at higher VPD. Grasses and sedges exhibited twice as high light utilisation efficiency (α) and attained higher photosynthetic capacity during the Entire growth period (Fig. 6 & Tab. 1), compared to the mosses. The ecosystem respiration (Reco) was positively correlated with temperature and negatively correlated with ground water level (GWL) (Fig. 7 & 8).

Hypotheses: 1.) Changes in ground water level influence CO_2 exchange in the bog but these changes vary with microhabitat diversity
2.) There are inter-specific variabilities in CO_2 exchange processes in the bog

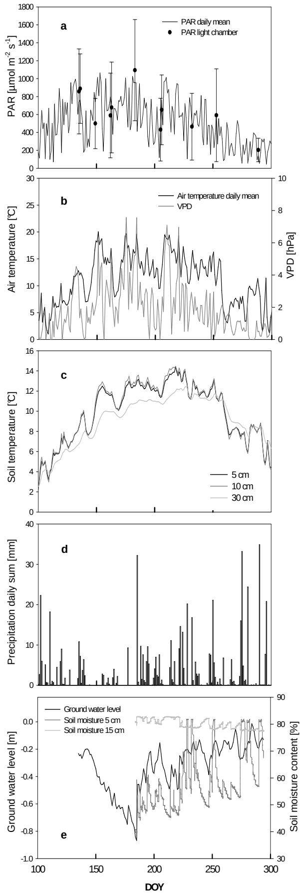

Figure 1. Prevailing weather conditions (a, b, c, d) and ground water level with soil moisture content (e) at the study site during the measurement period

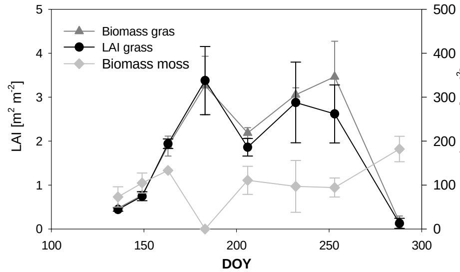

Figure 2. Seasonal variation in green biomass of grass and moss

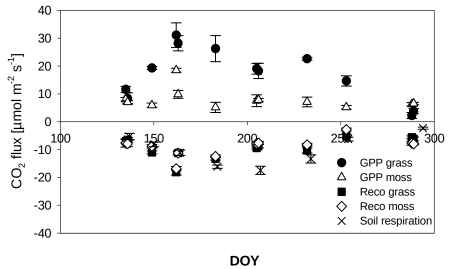

Figure 3. Seasonal course of GPP, Reco and soil respiration from grass and moss plots

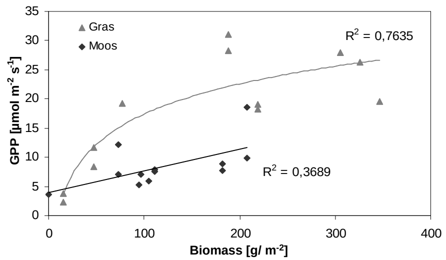

Figure 4. Relationship between GPP and biomass of grass and moss plots during the season

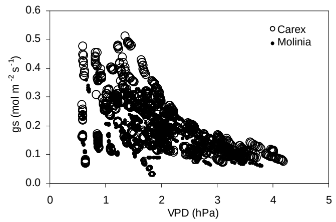

Figure 5. Regression between stomatal conductance (g_s) and vapor pressure deficit (VPD)

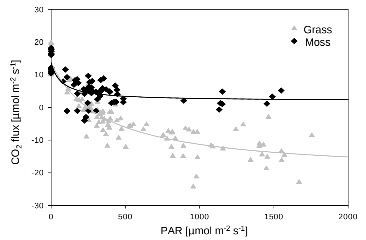

Figure 6. Fitted light curve of moss and grass plots from the empirical hyperbolic light response model

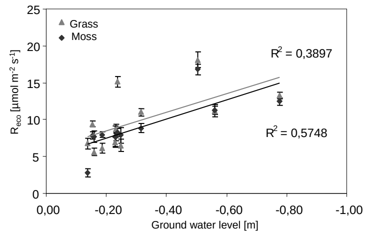

Figure 7. Correlation between ecosystem respiration and water level in the bog

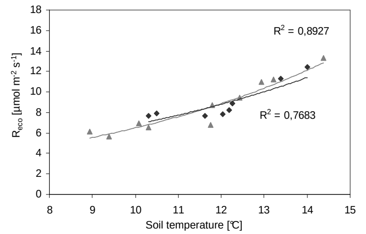

Figure 8. Correlation between ecosystem respiration and soil temperature in the bog

Table 1. Best-fit Parameters of the Empirical Hyperbolic Light Response Model for (A) Grass NEE (B) Moss NEE and their statistics

DOY	R^2	α	β	γ	$(\gamma+\beta)_{2000}$	S.E. α	S.E. β	S.E. γ
A) Grass								
135	0,9774	-0,0252	-7,5241	6,9905	13,537	0,0096	0,8608	0,2776
136	0,6516	-0,0086	-8,5011	6,4904	12,180	0,0111	8,9324	1,08
149	0,9488	-0,0923	-24,2921	11,089	32,556	0,0133	1,5529	0,528
162	0,922	-0,1985	-31,4027	18,1942	47,295	0,042	2,3223	0,9643
163	0,9008	-0,0835	-35,714	11,4939	40,915	0,0147	2,6168	0,9764
183	0,8957	-0,4017	-26,4055	13,346	38,911	0,1885	2,4723	1,7025
205	0,9165	-0,1044	-19,4409	9,3365	27,121	0,0173	1,3649	0,5385
206	0,9144	-0,0927	-19,9792	8,7239	26,760	0,0223	1,7892	0,7156
232	0,9008	-0,0836	-29,9192	10,8727	36,251	0,0173	2,7944	0,9888
253	0,8771	-0,0406	-20,4183	4,7822	21,098	0,013	2,941	0,7486
289	0,9263	-0,0404	-8,2966	6,1387	13,663	0,0201	3,9221	0,377
B) Moss								
135	0,8562	-0,0463	-8,7015	7,6918	15,646	0,0312	1,5066	0,6431
136	0,9597	-0,0524	-5,7114	7,9001	13,316	0,1042	1,5506	0,4132
149	0,9834	-0,0383	-11,4858	8,8811	18,869	0,0071	1,0651	0,299
162	0,9749	-0,1116	-21,355	16,9008	36,391	0,0153	1,1103	0,5366
163	0,9411	-0,0348	-12,0734	11,263	21,552	0,0094	1,7522	0,5466
205	0,9539	-0,031	-10,1082	7,817	16,5084	0,0068	1,1387	0,3646
206	0,9804	-0,0483	-8,3681	7,6784	15,379	0,0132	0,672	0,251
232	0,9205	-0,0202	-9,5497	8,5232	16,247	0,0093	2,7232	0,583
253	0,932	-0,026	-3,7802	2,7813	6,3053	0,0079	0,4269	0,1475
289	0,9597	-0,0408	-12,2507	7,9699	18,621	6,768	0,0165	0,3652

Discussion: Compared to mosses, grasses and sedges were least affected by fluctuations of the GWL in the peatland. Mosses preferred cool and sheltered areas within the habitat and were very sensitive to increased light and VPD. These differences are attributed to differences in plant physiology among the different vegetation types, which determines how they respond to their biotic environment. The predicted higher temperatures and drought periods during the season, arising from climate change, could lead to a stronger CO_2 efflux from a bog ecosystem.

References: **Droesler M. 2005:** Trace gas exchange of bog ecosystems, southern Germany. Lehrstuhl für Vegetationsökologie. Doctoral Thesis, Technical University of Munich
Owen K., Tenhunen J., Reischtein M., Wang Q., Falge E., Gayer R., and others **2007**: Comparison of seasonal changes in CO_2 exchange capacity of ecosystems distributed along a north-south European transect under non water stressed conditions. GlobalChangeBiol13: 734–60
Otieno D., Wartinger M., Nishiwaki A., Hussain M., Muhr J., Borken W., Lischeid G. **2009**: Responses of CO_2 Exchange and Primary Production of the Ecosystem Components to Environmental Changes in a Mountain Peatland. Ecosystems 590-603(14)