Westfälische Wilhelms-Universität Münster

CO_2 and CH_4 fluxes of contrasting pristine bogs in southern Patagonia (Tierra del Fuego, Argentina)

Wiebke Münchberger[1], Christian Blodau[1], Till Kleinebecker[1], Verónica A. Pancotto[2]

Introduction

Patagonian bogs cover a wide range of the southern terrestrial area and have been accumulating organic material since the last glaciation up to now. They are – in contrast to northern hemisphere bogs – virtually unaffected by human activities. Thus, these extremely southern bogs provide the rare opportunity to study the functioning of pristine ecosystems which is of high value nowadays. So far, little attention has been given to these great carbon reservoirs which will potentially be affected by climate change.

We aim to fill the knowledge gap in the quantity of carbon released from these bogs and in what controls their fluxes.

Methods

We investigated the variability of carbon fluxes in two contrasting bogs in Tierra del Fuego (fig. 1) during austral summer from December 2014 to March 2015. *Sphagnum*-dominated bogs are similar to the ones on the northern hemisphere, while cushion plant-dominated bogs can almost exclusively be found in southern Patagonia (box 1). We conducted measurements with a closed chamber and determined gas concentrations with a portable, fast gas analyzer (Los Gatos UGGA) equipped with a pump providing a flow rate of 2 LPM. Chamber measurements were performed on microforms representing the main vegetation units. Dissolved pore water concentrations of CO_2 and CH_4 were determined using a diffusive equilibration technique.

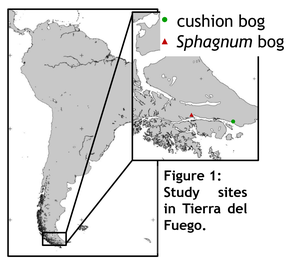
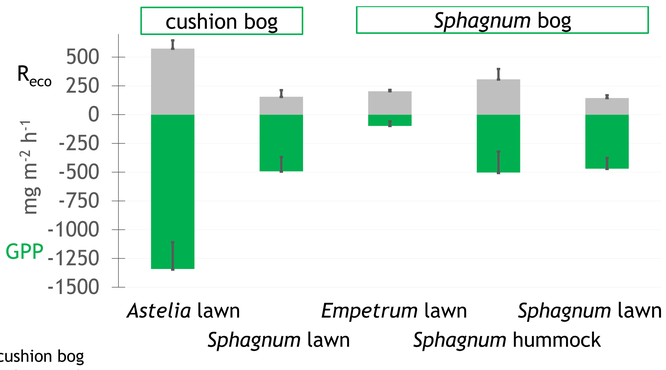


Figure 1: Study sites in Tierra del Fuego.

Results and discussion

- = uptake!	Net Ecosystem Exchange, mg m^{-2} h^{-1}			CH_4 emissions, mg m^{-2} h^{-1}		
microform	N	mean	SD	N	mean	SD
cushion bog						
Astelia lawn	17	-776.23	243.83	9	0.21	0.01
pool	5	143.99	105.81	6	0.19	0.17
Sphagnum lawn	18	-332.00	100.12	20	1.56	0.78
***Sphagnum* bog**						
Empetrum lawn	9	107.20	40.41	12	0.13	0.05
Sphagnum hummock	13	-196.11	183.31	15	0.54	0.29
Sphagnum lawn	13	-318.10	82.20	18	2.50	1.05

Table 1 (upper panel) and figure 2 (lower panel): NEE and CH_4 emissions (table) as well as GPP and R_{eco} (figure) measured at different microforms in two bogs in Tierra del Fuego. Mean and SD of fluxes calculated from four measurement days are given.



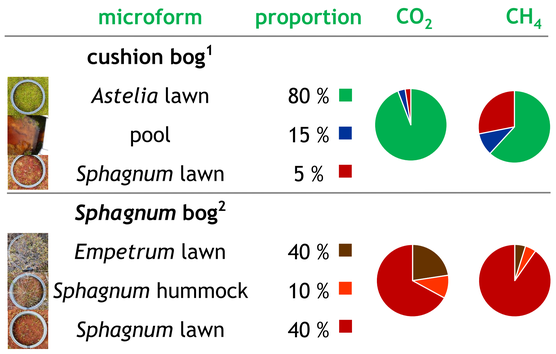


Figure 3: Percentage cover of microforms in two different bog types in Tierra del Fuego and relative contribution of microforms to total CO_2 and CH_4 fluxes of the respective bog type. Percentage was (1) estimated or (2) calculated from UAV data (Nieberding 2013). Pools cover 10 % of the area in *Sphagnum* bogs and their fluxes in both, CO_2 and CH_4, were not available for the analyzed days and negligible over the season.

The four days analyzed as an example for flux patterns were characterized by clear sky with PAR values up to 2000 µmol m^{-2} s^{-1} and air temperatures not higher than 13 °C. During these days, the net CO_2 exchange in the cushion bog was up to twice as high as in the *Sphagnum* bog (tab. 1, fig 2). Gross primary productivity (GPP) and ecosystem respiration (R_{eco}) of the dominant vascular cushion plant *Astelia pumila* caused this high net CO_2 exchange in the cushion bog (fig. 2). Lower PAR and thus GPP might (easily) switch the cushion bog from a CO_2 sink to a CO_2 source.

CH_4 emissions released by *Sphagnum* lawns in the cushion bog were seven times higher compared to emissions from pools and *Astelia* lawns (tab. 1). Nevertheless, total CH_4 emissions from the cushion bog were probably negligible because of the low cover of this microform (fig 3). In contrast to the cushion bog, *Sphagnum* microforms cover large areas in the *Sphagnum* bog (fig. 3) and – because fluxes from *Sphagnum* microforms were in the same order of magnitude in both bog types (tab. 1) – turned the *Sphagnum* bog into a larger CH_4 source. Negligible CH_4 emissions were the result of low pore water CH_4 concentrations below *Astelia* lawns (fig. 4b) that have been explained by a dense *A. pumila* rooting system down to 2 m depth (Fritz 2011). Interestingly, these roots might have affected even sparsely rooted peat below pools (fig 4b).

Further visual data inspections emphasized the importance of the vegetation type for CH_4 fluxes since soil temperature and water table fluctuations were negligible.

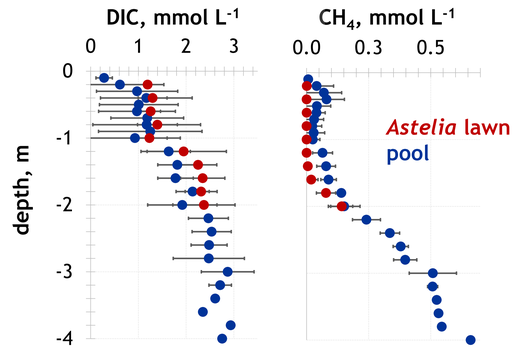
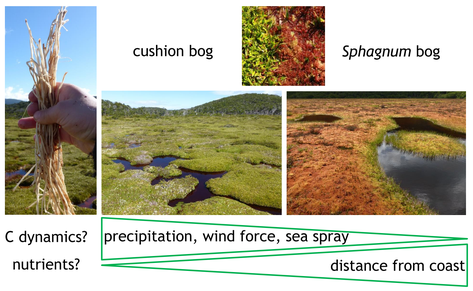


Figure 4 a, b: Pore water concentrations of DIC (a, left) and CH_4 (b, right) down to a depth of 4 m below 3 *Astelia* lawns and 3 pools. Mean and SD are given, except for depths where only one data point is available.

BOX 1: What is a cushion bog?



Implications and outloock

Carbon fluxes of the two bog types appear to be highly different with a pronounced spatial variability within and between bogs. This variability is probably the result of controls by plant functional traits and different environmental conditions.

Further analysis will include the evaluation of this variability and the investigation of daily and seasonal flux patterns.

ILÖK Institut für Landschaftsökologie

Hydrology Group & Ecosystem Research Group
[1]Institute for Landscape Ecology, WWU Münster
[2]Centro Austral de Investigaciones Científicas (CADIC), Ushuaia

CADIC CONICET

References:
Fritz et al. 2011, New Phytologist
Nieberding 2013, B.Sc. thesis WWU Münster
maps generated at sfb574.geomar.de/gmt-maps.html, 05.04.15

Acknowledgements:
This work is funded by the German Research Fundation (DFG) and is supported by the Administración de Parque Nacional Tierra del Fuego.

Contact:
wiebke.muenchberger@uni-muenster.de
c.blodau@uni-muenster.de