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Zero to moderate methane emissions in a densely rooted, pristine Patagonian bog – biogeochemical controls as revealed from isotopic evidence

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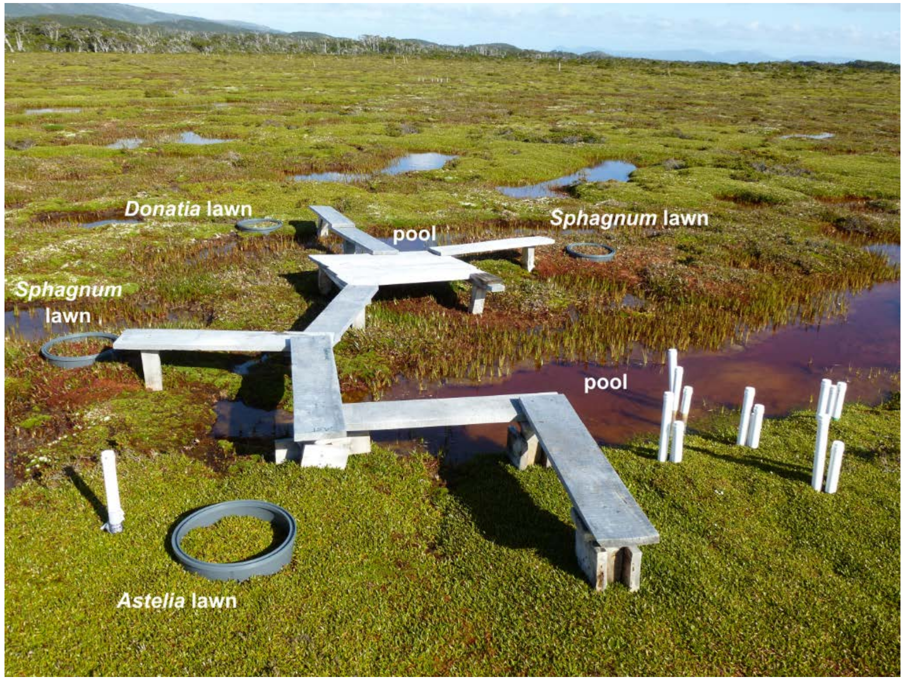

Figure S1. Arrangement of collars at platform 3 in the study site. Boardwalks were not installed between platforms to minimize disturbance of the cushion vegetation surface. Picture taken by Isabella Närdemann. Note the different types of microforms.

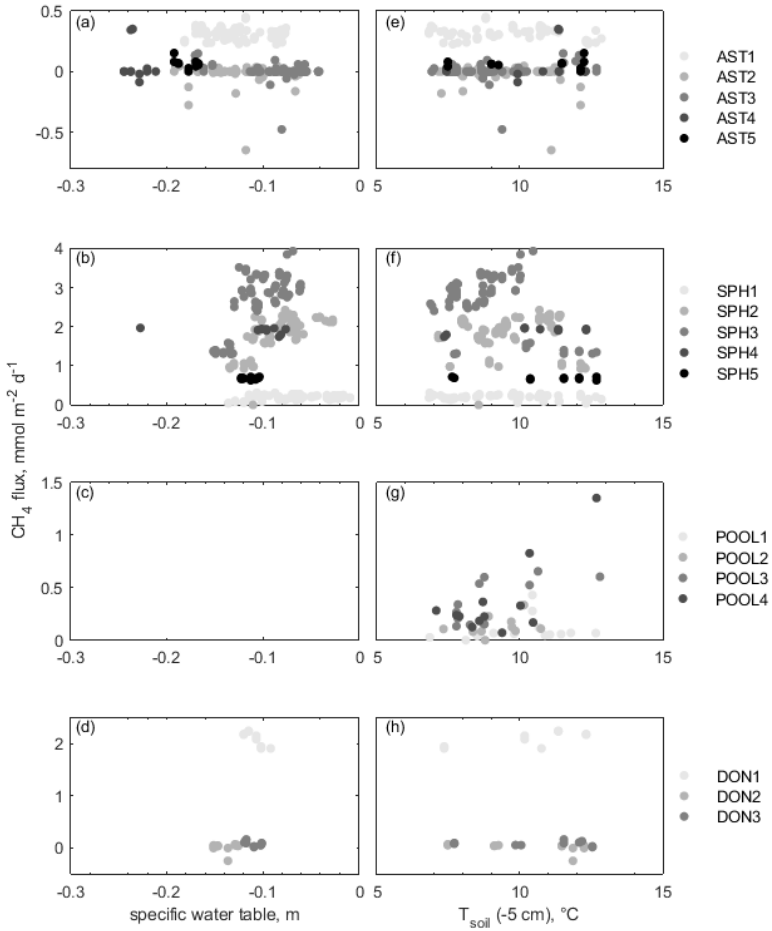

Figure S2 a-h CH_4 fluxes measured from individual collars of dominant microforms (*Astelia* lawns (a,e), *Sphagnum* lawns (b,f), pools (c,g) and *Donatia* lawns (d,h)) in a Patagonian cushion bog plotted against water table depth and soil temperature. CH_4 emissions were mostly decoupled from environmental controls probably since CH_4 fluxes were negligible in many cases. Obviously, individual collars of microforms with non-zero emissions released different amounts of CH_4.

Identification of CH_4 production and consumption zones applying PROFILE

Methods

Zones of CH_4 production and consumption in the peat column were quantitatively identified by inverse modelling based on pore water profiles of CH_4 concentrations using the software routine PROFILE (Berg et al., 1998). Steady-state conditions as well as a dominance of diffusive gas transport over ebullient events and aerenchymatic transport would have to be assumed. Given the large root biomass, this may only partly apply to the system under study here. Therefore, the modelling approach provided only rough estimates for production and consumption zones due to the complex diffusivity in the rhizosphere of highly rooted peat. Nevertheless, diffusion coefficients for CH_4 were derived from Lermann (1988) and corrected for mean soil temperatures (of 10°C in February 2015 and 2016 as well as 7°C in April at a depth of 0.5 m) as well as porosity. Porosity ϕ was calculated as (Eq. A1)

$$\varphi = 1 - \frac{\rho_{\text{bulk}}}{\rho_{\text{particle}}}$$

where ρ bulk is the bulk density (g cm^{-3}) and ρ particle the particle density (g cm^{-3}). Particle density was assumed to be 1.5 g cm^{-3} (Weiss et al., 1998). Below *Asteli*a lawns, the porous media available for diffusion was reduced by presence of roots and porosity was calculated considering the average root biomass throughout the rhizosphere. The software input requires equal depth zones and thus data were averaged to get a 0.2 m resolution over the whole profile, if necessary. The model results were evaluated at a significance level of 0.05.

Results and discussion

The lower rhizosphere of *Astelia* lawns was the most pronounced sink of CH_4, while in the upper rhizosphere production of (small amounts) of CH_4 was balanced by CH_4 oxidation (fig. A3, a-f). Zones of CH_4 consumption below pools (fig. A3, g-l) roughly corresponded to zones of CH_4 consumption of *Astelia* lawns while near the surface net production also approached zero. These zones of CH_4 consumption in relatively great depths below pools support our assumption of a lateral concentration gradient distributing e.g. CH_4 and O_2 along adjacent microforms. The pool sediment was identified as a zone of CH_4 production in two cases, possibly due to the availability of degradable organic matter from submerged *Sphagnum*. The near-zero diffusive CH_4 flux was consistent with low emission measured by chambers. Deep peat layers below those sampled would probably indicate intense CH_4 production.

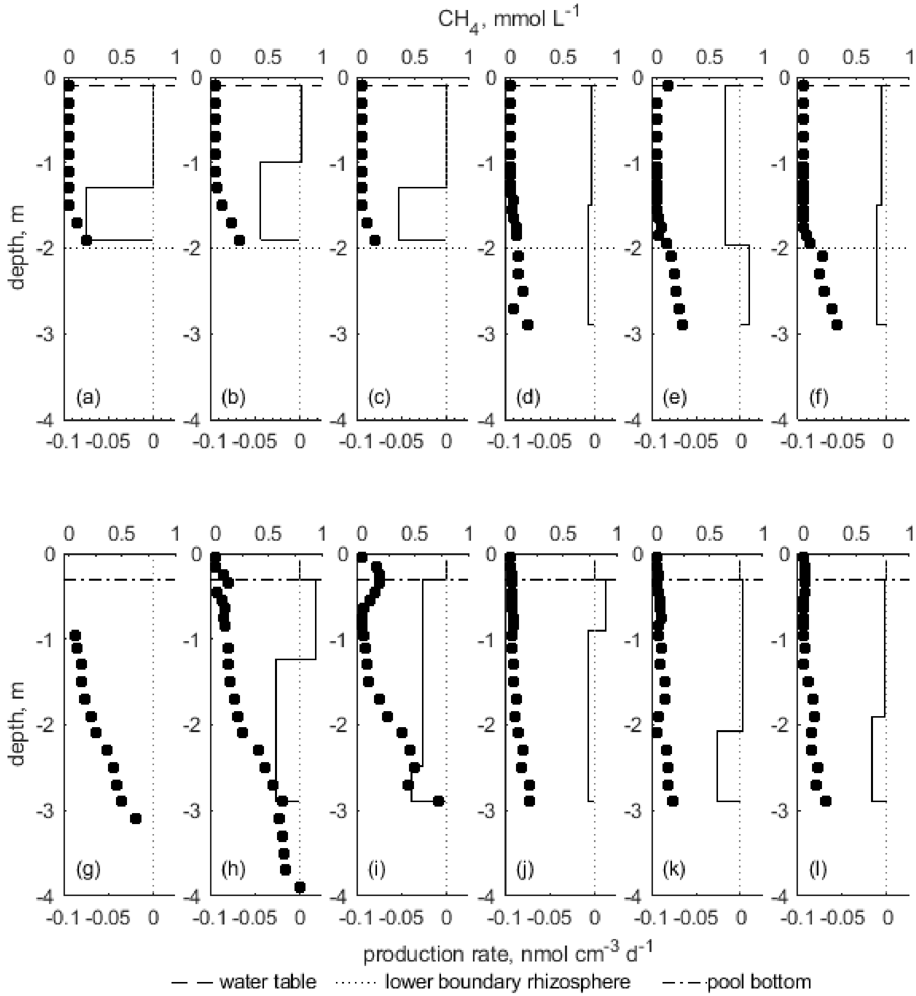

Figure S3 a-l CH_4 pore water concentration depth profiles obtained from MLPs installed in *Astelia* lawns and pools during two sampling campaigns in austral summer 2015 and 2016. Displayed depths represent the centre of a MLP segment. Note that no data were available for the upper profile of pool 1 and that modelling of production rates did not include all data obtained from pool 2 in 2015 for depth consistency. Concentrations are given per volume of pore water while production rates are given per volume of peat.

References

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