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A comparison of linear and exponential regression for estimating diffusive methane fluxes by closed-chamber – results from laboratory and field campaigns

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Closed chambers are the most common method to determine methane (CH_4) fluxes in peatlands. The concentration change over time is monitored, and the flux is usually calculated by the slope of a linear regression function. However, chambers tend to slow down the gas diffusion by changing the concentration gradient between soil and atmosphere. Theoretically, this would result in a near-exponential concentration change in the chamber headspace.

Here, we present data from a laboratory experiment and from two field campaigns on the basis of which we evaluate flux calculation approaches based either on linear or exponential regression models. To compare the fit performances of the two models, we used the Akaike Information Criterion with small sample second order bias correction (AIC_c). For checking the quality of flux data, we used the standard deviation of residuals.

The calibration system in the laboratory experiment used during the chamber calibration campaign at Hyytiälä Forestry Field Station in August 2008 has been described by Pumpanen et al. (2004). Five different flux levels on two different soil porosities where tested. Preliminary results show that most concentration-over-time datasets were best described by the exponential model as evaluated by the AIC_c. It appeared that the flux calculation using the exponential model was better suited to determine the preset fluxes than that using the linear model.

In the dataset of the first field campaign (April to October 2007) from Salmisuo (Finland, 62.46˚ N, 30.58˚ E), however, the majority of fluxes was best fitted with a linear regression on all microsite types. Those fluxes which are best fitted exponentially are most probable due to chamber artefacts. They occurred mostly during a drought period in August 2007, which seemed to increase the artificial impact of the chamber. However, these results might be site-specific: In Ust-Pojeg (Russia, 61.56˚N, 50.13˚E), where CH_4 emissions are supposed to be higher than in Salmisuo, more fluxes (ca. 30% during April to June 2008) were selected to be best fitted with an exponential regression.

References:

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