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Biogeosciences Discussions

Interactive comment on "Spatial and temporal variation of methane emissions in drained eutrophicpeat agro-ecosystems: drainage ditches as emission hotspots" *by* A. P. Schrier-Uijl et al.

A. P. Schrier-Uijl et al.

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Preliminary reply to anonymous reviewer 1:

We would like to thank the first reviewer for the detailed comments on our paper. The reviewer raises a number of critical points that are well taken. Some of them have indeed also at one stage or another been considered during the writing process. The reviewer points out a number of uncertainties in the paper that need to be addressed in more detail. We agree with him/her that in general great uncertainty exists in the measurement and calculation of methane balances. For the sake of an open discussion we would like to submit a preliminary response to some points made now, while in our final response we will deal with all issues raised in more detail.

Uncertainty of balances:

The reviewer is critical of the weak predictive power of the temperature regression lines and the lack of biological parameters that could help understand the spatial and temporal patterns of the CH4 fluxes and we agree when he/she suggests that more information is needed about the uncertainties of the year balances as calculated with linear regression and trapezoidal integration.

Indeed temperature relations with methane emissions are not strong (eg. This paper, Hendriks et al, 2007, van den Pol-van Dasselaar et al, 1998, Minkkinen and Laine, 2006). This is in itself not surprising. As the reviewer points out the methane emitted from the surface is the result of complex, partially counteracting processes. An example is the dependency of methane emission on irradiation during growing stage of the grass (Xianonan Duan et al., 2005). If methane emission depends on temperature as main predictor the following must hold:

1) Temperature is the most important variable to which methanogenesis responds 2) Methanogenesis responds immediately to T-changes 3) Availability of organic substrate is not limiting, particularly of labile carbon pools 4) Micro-organism presence is not limiting and activity of methane producing organisms depends on temperature and moisture 5) Methane transport is not limiting nor delayed. 6) Methane oxidation responds similarly to temperature

Effectively, we know that this cannot be valid. We for instance expected a strong influence from anaerobic versus aerobic conditions in the upper part of the soil caused by water table fluctuations reducing methane oxidations. As the reviewer points out, production, oxidation and consumption of CH4 appear to produce a great variation and in general R-squares of temperature regression lines are weak. Over shorter time horizons relationships are sometimes highly significant (eg. Hargreaves et al 1998, Ding et al, 2003,). In our analysis, using soil moisture or water level fluctuations, did however not enhance the predictive power of the relationships significantly.

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The reviewer also points to the possibility of differences between day and night time due to the priming effect from labile carbon exudated from the roots during daytime, while the possibility of illuminated bulk transport in vegetation with significant aerenchymeous has also been reported e.g. (Chanton et al 1993). In other studies however (e.g. Hargreaves & Fowler, 1998) no systematic effect has been found other than explainable through temperature differences between day and night.

We have in the last two months expanded our measurements with night time measurements, but up to now not yet found a day night time effect in water bodies, while measurements from the soil surface are about to commence. Already for longer period we are comparing chamber and eddy covariance measurements for methane (Kroon et al, 2007) in the Oukoop site to focus on the separation of seasonal emissions and event-emissions. Preliminary analysis shows temperature regression estimates based on upscaling of the chamber measurements from different landscape scale elements of CH4 fluxes to be generally in good agreement to the Eddy Covariance results. This indicates a robustness of the temperature regression-based estimates and a certain randomness (at least no specific bias) in the observed variation of fluxes based on chamber measurements. We intend to submit this paper also to Biogeosciences Discussions. (Schrier, Kroon et al. in prep.). We find a trend of chamber fluxes to be on average higher at low methane emission rates and somewhat lower at high emission rates compared to EC measurements. Temperature regression based on chamber fluxes may underestimate emissions immediately following manure gifts. Overall the difference between the two methods amounts to 15%, (the analysis is not yet complete).

Perhaps the greatest difficulty with chamber measurements is the problem of episodic events e.g. because of episodic ebullition from water bodies (Huttunen et al, 2003; Bubier et al, 1993; Minkkinen and Laine, 2006). During non-winter periods wind and temperature may combined cause occasionally large fluxes as reported in our paper. These also form part of the regression and are integrated in EC measurements. We

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demonstrate in this paper that handling these with the exponential regression results in large differences with simple trapezoidal integration. We think we are justified to follow the former method because:

1) Logarithmic regression gives a better fit than a linear relationship. 2) The temperature regression based upscaling from the landscape scale already shows a good agreement with the area integrated based EC measurements.

Novelty of the present paper:

The aim of this paper was to study spatial and temporal emission patterns in fen meadow ecosystems at landscape scale. Particularly the role of small water bodies has so fare been reported on in few studies (Minkkinen and Laine, 2006) and is therefore often overlooked. The site of Hendriks et al, 2007 is a very different site in terms of management and vegetation cover. The largest part of the fen meadow area in Atlantic Europe is intensively or extensively managed, and therefore estimates of CH4 emission can not be based on data of the nature reserve of Hendriks et al. 2007 only. The important role of water bodies needs in our view to be brought to the attention of the scientific community . It seems important to us that different sites can only reliably be compared using chamber measurements when landscape elements to be studied separately. This in our view validates the writing of this manuscript. It also may prove an important management tool for manipulating the GHG balance of fen meadow ecosystems.

We hope that the first reviewer with this additional information will have more confidence in the reliability and robustness of the reported results. Again we thank him for generating this discussion and forcing us to become more clear.

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